Effect of Acid Rain on Human Living Environment and Human Self

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Abstract. There have been countless scientists studying acid rain from the 1970s to the present, and of course, there have been reviews and studies of this kind, but these studies are not enough. The influence of acid rain on human beings, as well as the environment, is discussed in this paper. First, the production of acid rain is caused by a mix of human activities, as well as natural processes. Human activities like burning fossil fuels, industrial emissions, and transportation release pollutants such as sulfuric and nitric acid, as well as acid rain, are produced when sulfur dioxide (SO_2) and nitrogen oxides (NO_x) in the atmosphere combine with water vapor and oxygen. Acid rain creates a large bad effect to the ecosystem. It harms water bodies, soils, vegetation, and biodiversity. In addition, acid rain poses a threat to human health. Pollutants in acid rain can irritate the respiratory system and cause respiratory diseases. To combat the problem of acid rain, both individual and government efforts are critical. In the future, people need to develop technology and do more research to solve acid rain. The meaning of the essay is to let more people know about acid rain, how acid rain affect the world, and what human can do to solve acid rain.

Keywords: Acid rain; cause; impact; future; meaning.

1. Introduction

The problem of acid rain was first widely concerned by the scientific community in the 1970s, when the phenomenon of acid rain began to appear in some industrialized countries. The researchers found that this acidic precipitation not only caused great damage to the environment but also had a serious impact on human health and economic development. Therefore, the study of acid rain has become an important scientific topic. The purpose of studying acid rain is to understand how acid rain form and how it works and its impact on human health and the social economy. The research of acid rain is of great significance. First, acid rain has a far-reaching impact on the environment. Through in-depth study of acid rain formation mechanism and influence process, it can provide a scientific basis for environmental protection and ecological restoration. Secondly, acid rain has a bad effect on human health. Therefore, the study of the relationship between acid rain and human health is helpful to formulate corresponding protective measures and policies to protect public health.

There have been countless scientists studying acid rain from the 1970s to the present, and of course, there have been reviews and studies of this kind, but these studies are not enough. Much research on how to reduce acid rain and future trends in acid rain is still needed. Compared with other reviews, this paper gives a comprehensive description of acid rain, including its causes, harm, and solutions.

The objectives of this article are to introduce the effects of acid rain on human beings and the environment. Firstly, the human and natural causes of acid rain are briefly introduced. Then the water, soil, building, human health, and other aspects of the harm of acid rain were elaborated. Finally, the methods to deal with acid rain are given respectively from two aspects: individual and government.

2. Causes of Acid Rain Formation

Acid rain is created if gases like sulfur dioxide and nitrogen oxides, which can travel very high into the atmosphere, mix and chemically react with oxygen, water, and other compounds as shown in Fig. 1. There are chemical equations for sulfur dioxides causing acid rain as shown in the formula (1)

and (2). There are tchemical equations for nitrogen oxides causing acid rain as shown in the formula (3).

$$SO_2+H_2O=H_2SO_3 \quad (1)$$

$$2H_2SO_3+O_2=2H_2SO_4 \quad (2)$$

$$4NO_2+2H_2O+O_2=4HNO_3 \quad (3)$$

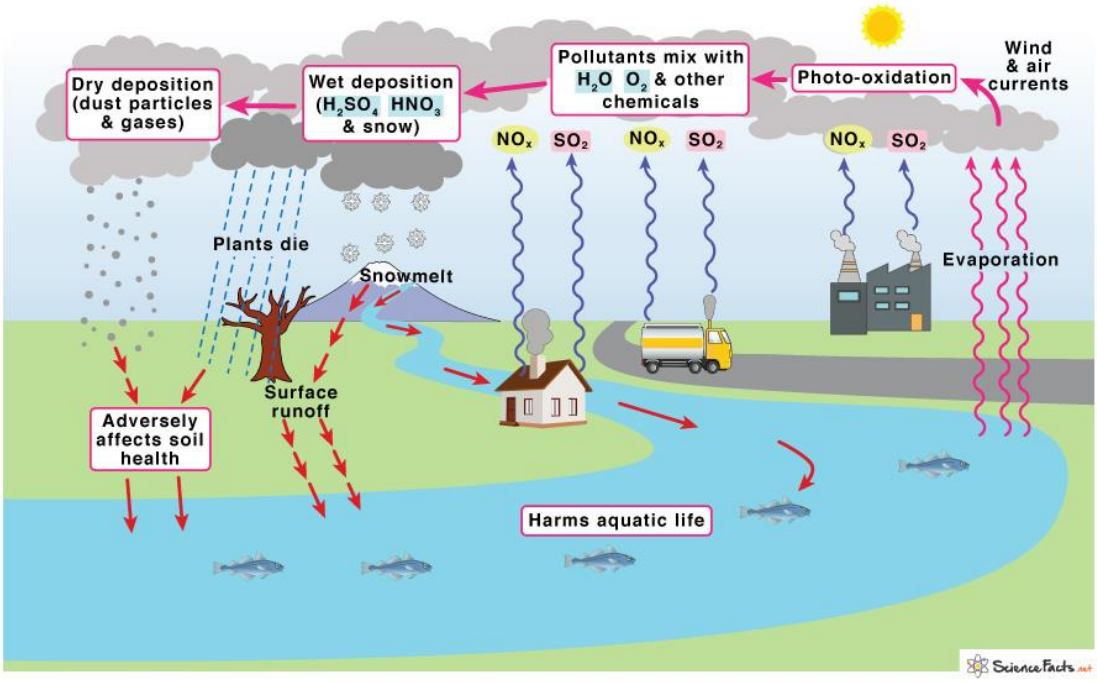

Fig 1. Acid rain. https://www.sciencefacts.net/acid-rain.html

2.1. Reasons Caused by Humans

Sulfur is present in coal, which when burned releases a lot of sulfur dioxide. As a result, the majority of sulfur dioxide (SO_2) emissions are produced by the act of burning fuel in industry and power plants. In addition, a significant amount of sulfur dioxide gas is generated during the reduction of ore to metal. Additionally, nitrogen and oxygen in the air combine to generate nitric oxide when coal is burned at a high temperature. Nitric oxide is subsequently transformed into nitrogen dioxide nitrogen dioxide, which results in acid rain. Approximately 50% of the gas's nitrogen oxide emissions are caused by automobiles.

2.2. Reasons Caused by Nature

Nitrogen oxides and sulfur dioxide can go into the air as a result of volcanic eruptions, lightning, natural fires, and microbiological activity. Certain soil creatures, such as dead animals and plant leaves, can decompose certain sulfides, which are then converted into sulfur dioxide by bacteria. Nitrates, which soil bacteria use to break down gases like nitric oxide, nitrogen dioxide, and nitrogen, are present in even unfertilized soil in tiny amounts. Because trees also contain trace quantities of sulphur and Australia's bushfires are not aware of the amount of acid rain they contribute to, bushfires brought on by lightning and dry heat are additional natural sources of sulphur oxide emissions. Strong energy from high-altitude rain cloud lightning can mix oxygen and nitrogen in the air to create nitric oxide, which is eventually changed into nitrogen dioxide in the troposphere. Nitric oxide and nitrogen dioxide together make up nitrogen oxides, which combine with airborne water vapor to produce nitric acid. Sulfur dioxide gas is released in significant quantities during volcanic eruptions.

3. Harm of Acid Rain

3.1. Water

As a result of acid rain, dangerous elements such as aluminum, lead, and mercury in the soil are dissolved and washed into nearby bodies of water, causing water pollution. Acidification causes granite to release more aluminum. Aluminum can reduce size or body weight and create chronic stress, which can make fish compete less effectively for food and habitat. Moreover, only a few eggs hatch, adult fish could perish, and other vulnerable species, such as snails and clams, cannot survive where pH is below 5.5 [1]. Although some species, like frogs, can survive lower pH, species of their prey, such flies, cannot. Thus, both frogs and prey populations will decline [2, 3]. The interconnectivity of food chains impacts ecosystems. The release of toxic heavy metal ions into the water body will prevent fish from developing and growing. These ions include copper, nickel, chromium, cobalt, lead, and zinc ions. In addition to impeding growth, stress, and immunity, the acidic environment and the toxicity of heavy metals can also harm the egg and larval stages and limit the success of spawning and reproduction in fish. Another important factor in intermittent acidification is nitrogen dioxide deposition in water bodies. About 10% to 45% of nitrogen dioxide (NO_2) in water bodies is airborne and released into the atmosphere primarily by human causes. The juvenile stages of shelled mollusks, shellfish, coral reefs, seagrass, and aquatic life are all affected by acidification. In an acidic environment, the skeletons and shells of corals and shellfish composed of calcium carbonate decompose [4]. Low-pH acid rain encourages the growth of species that can withstand the acid, including certain bacteria and protozoa. However, the life and reproduction of plants and animals are not supported by these compounds and acidic surroundings. Acid rain also causes a drop in the water's dissolved oxygen content, which makes it harder for fish to breathe. They may pass away from acid rain-related asphyxiation and poisoning. These dangerous compounds affect fish, which are consumed by birds and build up in their bodies. The animals who consume the birds then receive these compounds from the other species. Chemicals progressively make their way up the food chain in this fashion. The chemical's concentration rises exponentially at every step. This process is referred to as biomagnification.

3.2. Soil

Soil is one of the most significant ecological factors. It is the only source of water and nutrients for all vegetation. Soil systems are extremely dynamic and complicated. Increased hydrogen ion exchange in the soil with nutrients including potassium, magnesium, and calcium results from acid rain's acidity of the soil. With the help of the acid input sulfate, these cations can quickly drain out of the soil solution after being discharged into it [5]. In the damaged soil, acid leaching causes nutrient deficiencies, and the loss of soil fertility inhibits plant growth, including tree growth, in soil that is acidic. Cycles of nutrients and breakdown rates are negatively impacted by soil acidity as well. Strong acidity prevents the breakdown of litter made of materials high in cellulose, such as spruce, pine, birch, and others, according to studies [6, 7]. In addition, the soil contains harmful minerals including aluminum and mercury. Because plants and trees cannot absorb them, these compounds are safe. However, these compounds interact chemically with the acid when exposed to acid rain. When acid rain leaches alkaline cations like calcium and magnesium from the soil, it can dramatically alter soil chemistry and have an impact on sensitive species such as Aceisaccharum, as shown in Fig. 2 [8, 9]. Thus, a mixture of aluminum, lead, and mercury is created. These substances are easily absorbed by plants and trees. These substances eventually have an impact on the entire food chain and are extremely dangerous to living things. These substances affect both the animals that eat them and the plants. Acid rain can adversely affect soil biology and chemistry. Some bacteria cannot survive changes in low pH and die as a result [10]. The acid denatures the enzymes of these microbes, rendering them inactive. In addition to mobilizing contaminants like aluminum, hydrogen hydrate ions in acid rain can also cause the loss of vital nutrients and minerals like magnesium [11].

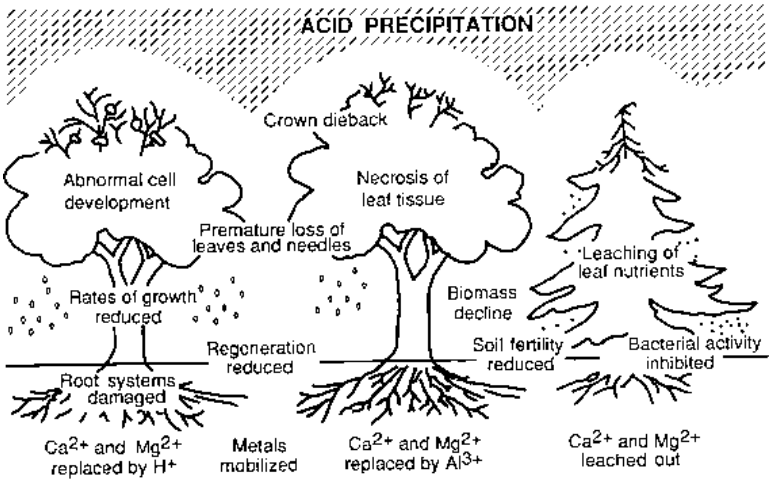

Fig 2. The impact of acid rain on the terrestrial environment.
https://www.briangwilliams.us/environmental-issues/acid-rain-and-the-terrestrial-environment.html

3.3. Architecture

Acid rain wreaks havoc on buildings and marble statues. Acid degrades marble, which includes bronze and alloy structures. Calcium sulfate, a kind of powdered substance that can be quickly removed by water, which also suggests that rain may remove it with ease, is created when acid rain combines with calcium carbonate to produce soluble water, carbon dioxide, and calcium sulfate. Many notable buildings and monuments, including the Taj Mahal in India, have been partially damaged by acid rain. Acid rain with phenol concentrations more than 3.0 but less than 5.0 has an impact on concrete and cement [11], concrete high-rise structures in metropolitan settings have been harmed by extended exposure to highly acidic cloud water [12], and the Red Fort and Jamasdar in Delhi also showed signs of damage caused by sulfur pollution [13]. Affected structures by acid rain include railroad tracks, steel bridges, and church-stained glass windows. Metal is corroded, paint colors are destroyed, leather is weakened, and hard shells are formed on glass surfaces. Because nitric acid, sulfuric acid and sulfuric acid deposited in dew or rain on the car paint will fade the paint, modern car manufacturers paint the acid-resistant top paint on the car, and modern buildings paint the acid-resistant exterior paint. Formula (4) is the chemical equation of how acid rain reacts with marble.

$$CaCO_3+H_2SO_4=H_2O+CO_2+CaSO_4 \quad (4)$$

3.4. Human Health

Although rain is an intangible pollutant, it has some unintended consequences for human health. The damage to the human body caused by exposure to substances that are itself impacted by acidification, such as food, water supplies, and other adverse effects on human health in the form of gases and aerosols, are examples of indirect consequences. When combined with aerosols, fogs, and suspended smoke, SO_2 is much more toxic and destructive and causes more eye irritation at concentrations above 1.6 ppm [14]. This is because these chemical mixtures create finer suspensions that enter the lungs more effectively than gases alone. The eyes and skin can become irritated by polluted raindrops in Tokyo [15]. Toxic heavy metals, which are released from the soil as it becomes acidic, are factor in the indirect consequences of acid rain on human health. Aluminum, cadmium, zinc, lead, mercury, manganese, and iron are the most prevalent heavy metals [16]. These transported toxins infect food intended for human consumption, dissolve in soil and water, get into groundwater, and are absorbed by people [17]. These toxic metals build up inside the body and result in some health issues, including dry cough, asthma, headaches, and irritation of the eyes, nose, and throat. Asthma and bronchitis are among the cardiopulmonary disorders that are brought on by an increase in tiny particulate matter in the air.

4. Measures

4.1. Individual

Switching to renewable energy sources which are clean and can help reduce the amount of sulfur and nitrogen including wind energy, tidal energy, and geothermal energy to combat acid rain and reduce reliance on fossil fuels. Also using solar cells, fuel cells, natural gas, and electric vehicles is important. Thus, people should use less private cars and use more public transport.

4.2. Government

The government can switch to coal or oil with low sulfur content and replace coal or oil boilers with other energy sources like gas boilers. Use nuclear energy to generate electricity, maintain vehicles with low nitrogen oxide emissions, and plant boilers, such as cleaning chimneys, as well as exhaust pipes. Utilize boilers that consume less energy, and utilize filters or scrubbers to remove sulfur and nitrogen oxides from industrial wastes and from moving automobiles. Utilize electrostatic precipitators, which draw sulfur particles with positive charges to plates with negative charges. Chemical techniques, including dry washing techniques like fluidized bed combustion (FBC or circulating dry scrubber), which reacts with sulfur without a water medium, or wet washing techniques like water injection or chemical solutions like flue gas solution (FGS), which has a between 80% to 95% elimination rate for SO_2. Activated chemicals (like ammonia) are injected to change nitrogen oxides by reacting with them to nitrogen (N_2) and oxidation (O_2), changing the ratio of air to fuel combustion temperature. This process, known as the selective catalytic reduction process (SCR), has a nitrogen oxide 80% or more drop in rate. To promote the use of renewable energy and energy efficiency, the government should grant each plant a fixed amount of "subsidy" based on its annual sulfur dioxide emissions. Additionally, there are subsidies for geothermal, wind, and solar power projects.

5. Conclusion

Both people and the environment are significantly impacted by acid rain, a significant environmental problem. This essay's main goal is to describe how acid rain affects both people and the environment. First, a combination of people's action and natural processes contribute to the generation of acid rain. There is an atmospheric emission of pollutants including sulfur SO_2 and NO_x by people's action including the use of fossil fuels, producing emissions of industries, and driving. These pollutants mix with atmospheric oxygen and water vapor to generate both sulfuric and nitric acids, which eventually results in acid rain. Acid rain has a huge negative effect on the ecosystem.It harms water bodies, soils, vegetation, and biodiversity. When acid rain falls on bodies of water such as lakes, rivers, and streams, it acidifies the water body and adversely affects aquatic ecosystems and organisms. Acidic soils also affect plant growth and agricultural yields. Forests are also vulnerable to acid rain, leaving trees vulnerable and more vulnerable to disease and other stresses. In addition, acid rain poses a threat to human health. Pollutants in acid rain can irritate the respiratory system, triggering asthma, bronchitis, and other respiratory diseases. Long-term exposure to acid rain can have serious consequences for vulnerable people, especially children, the elderly, and those with pre-existing respiratory conditions. To combat the problem of acid rain, both individual and government efforts are critical. Individuals can adopt sustainable practices such as reducing energy consumption, using clean transportation and supporting renewable energy sources. In addition, the government contributes significantly to the creation of policy and regulations to reduce emissions from industrial activities and power generation. International cooperation is also key to solving the problem of acid rain, as it is a global problem that requires joint action and knowledge sharing. In summary, acid rain poses a significant risk to humans and the environment. Understanding its causes and effects is critical to developing effective coping strategies. By adopting sustainable practices and implementing

appropriate policies, we can reduce emissions that cause acid rain and protect ecosystems and human health.

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