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IMPACT OF ACID RAIN ON THE ENVIRONMENT

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The article touches on the topic of acid rain, which poses a serious threat to the environment. The idea is substantiated that the presence in the atmosphere of certain acid-forming compounds, primarily sulfuric and nitric acids, formed as a result of the chemical interaction of sulfur and nitrogen oxides with atmospheric water vapor, can lead to acidification of rainwater. It is noted that the interaction of acid rain and ecosystem elements leads to a disruption of the equilibrium processes occurring in the biosphere. Considerable attention is paid to the decrease in soil fertility as a result of acid precipitation, which leads to the leaching of vital plant substances from the soil and ultimately causes forest degradation. The article, due to acid precipitation and disruption of the natural cycle of substances, also analyzes the harmful effects of acidified precipitation on the biocenoses of closed water bodies (flora, fauna). It is emphasized that the disturbance caused by acid rain, having a negative impact, spreads to various abiotic and biotic components of the ecosystem. The purpose of the article is to analyze the study of the origin and negative consequences of acid rain, as well as to evaluate efforts to combat the negative impact of acid rain on the environment.

Keywords: *acid rain, forests, plants, soils, consequences.*

Introduction

In a world characterized by a growing population, urbanization, and developing nations striving to compete in the global market alongside post-industrial nations, the impact of acid deposition deserves greater attention. As global energy demand continues to increase, and with coal being the most affordable and abundant energy source, acid deposition is becoming more prevalent. This phenomenon is primarily driven by the release of sulfur dioxide (SO_2) and nitrogen oxides (NOx) gases, which are emitted into the atmosphere. While a small portion, approximately 5%, of these gases occur naturally through processes like forest fires and bacterial activity in decomposing vegetation, the majority, around 95%, are of human origin and result from activities such as burning fossil fuels like oil, coal, and natural gas [1].

When sulfur dioxide and nitrogen oxides are released into a moist atmosphere, they undergo a process of transformation, which involves oxidation (the binding of free oxygen to other elements and compounds) and dissolution (the dispersion of a substance into a liquid). This results in the creation of nitric acid (HNO_3) and sulfuric acid (H_2SO_4). In simpler terms, these gases become integrated into clouds and eventually descend to the ground as precipitation, which can take the form of rain, snow,

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fog, or mist; this phenomenon is known as "wet deposition." Wet deposition can also occur when ammonia gas (NH_3) from natural sources is converted into ammonium (NH_4). When scientists discuss wet acid deposition, they identify acidity by measuring the pH level of the precipitation. Typically, any precipitation with a pH below 5 is considered acidic. However, if the pH is lower than what is naturally expected or typical for a particular region, it can also be categorized as acidic [1].

Forests

Forests are an incredibly important and necessary ecosystem for humans and most all living things. Forests act as a huge carbon sink and are essential to keeping the carbon cycle in order, they are home to a huge number of plants and animals, and the biodiversity of forests is amazing. In fact, forests very likely could be home to a plant or insect or animal that could be used as a miracle medicine. Sadly, forests are being destroyed everyday by human deforestation and climate change. As this happens, we are upsetting the food chain and habitats of plants and animals, some of which may have provided miracle medicines. Compared to cutting of forests,, acid deposition induces only a small bit of damage to forests. But as we can see, forests are very, very important, and any bit of damage is detrimental to life on earth [2].

Regrettably, a significant portion of the research conducted on forest vegetation is focused exclusively on two tree species: red spruce and sugar maple. It's important to recognize that trees rely on the quality of the soil they grow in, which substantially influences their growth and overall health. Air quality is another critical factor affecting tree health. Firstly, acid deposition on the forest floor leads to the depletion of essential base cations, specifically calcium and magnesium. Secondly, during winter, a substantial number of injuries occur when acidic moisture in the form of mist and fog strips away vital nutrients from the trees' needles. The combined impact of these two factors makes trees far more vulnerable to various stresses, including defoliation caused by native insects, as well as extreme conditions like drought, heat, or cold. This issue is particularly prevalent in higher elevation areas. Additionally, trees in regions with low calcium content in the soil interact with acidic components in clouds more frequently compared to trees at lower elevations. Research conducted in the Adirondack, Green, and White Mountains has revealed that "in high elevation sites, 20 to 50 percent of the canopy spruce trees have perished due to acid deposition, but this dieback is not limited to high elevations; it is widespread throughout the range of these trees" [2].

Plants

Acid rain has dual direct impacts on plants, affecting both their development and physiological processes. Unlike vertebrate animals, where development concludes early in life and only growth occurs thereafter, plants maintain embryonic tissue throughout their lifespan. This embryonic tissue, housed within plant buds, continuously contributes to the formation of new leaves and flowers. However, this persistent embryonic tissue is susceptible to damage from acid rain, with the extent of vulnerability determined by the level of protection afforded to it [2].

Certain plants, such as pine trees and yellow birch, exemplify the visible consequences of exposure to acid rain through gross deformities. In the case of pines, this deformation manifests as shortened needles. When a substantial number of these short needles emerge, it significantly diminishes the photosynthetic capacity of the trees. This diminishes their overall well-being and jeopardizes their chances of survival [3].

Acid rain's impact on plants also extends to physiological aspects. The leaching of nutrients from the soil, identified as one consequence of acid rain, can similarly occur within the plant tissues as

rainwater, acidic from the deposition, flows over the surfaces of the plants. However, more significant are the repercussions on the photosynthetic processes [3].

Photosynthesis, the vital process through which plants convert sunlight into stored chemical energy in the form of carbohydrates, relies on the green pigment chlorophyll for capturing solar energy. It has long been established that chlorophyll, when extracted from plant tissue and exposed to an acidic environment, undergoes a process known as "bleaching," rendering it incapable of capturing sunlight energy. Yet, conflicting data exists regarding whether acid rain can induce bleaching of chlorophyll within intact plant tissues. While moss treated with simulated acid rain exhibited a reduction in chlorophyll content, beans subjected to the same treatment showed no impact on chlorophyll levels content at all [3].

Soils

Without healthy soil, nothing will flourish. Healthy soil is the base for all life. Healthy plant growth begins with healthy soils. Without healthy soils, plants don't grow, and the whole food chain is affected. Also, soils mitigate the quality of water feeding into streams. Healthy soils are the foundations for healthy life and acid deposition has wreaked havoc on this delicate system. Acid deposition mainly affects three elements in soils: aluminum, calcium, and magnesium. According to Greg Lawrence, a forest and terrestrial systems specialist at the U.S. Geological Survey, "calcium in the soil is very important". Calcium is "essential for wood formation in trees [..] and trees have a very high demand for calcium". If trees don't get the proper amount of calcium, their growth will be stunted; slowed to an unhealthy rate which leaves them susceptible to their foes: foreign insects and extreme weather events. In the soil, calcium" is the primary element that neutralizes acidity, whether the acidity was generated through natural organic acids in the soil or by acid rain". Calcium acts as a buffer to acidity, and when soil is healthy, all acidity is fully buffered out by calcium [3].

At different depths, soil chemistry differs; this has a big influence on the amount of calcium available to trees. Organic materials (leaves, branches, and other decomposing matter) that fall from trees or have somehow ended up on the forest floor, and certain types of rocks, when weathered, produce calcium that is available to plants. Carbonate bedrock, such as limestone "provides substantial buffering of acid "whereas" basaltic, granitic, and siliciclastic bedrock types represent a series of decreasing levels of buffering capacity". On and near the surface of a forest floor, there is a layer called the organic horizon. In the organic horizon "there is very, very intense root activity, and recycling of calcium". The organic horizon is fairly low in calcium, "so as soon the plant material decomposes and releases some calcium, there are plenty of roots there to grab it, and that prevents it from leaching out of the soil". Deeper down in the soil, below the organic horizon, is a layer called the mineral horizon. Calcium is usually maintained in the mineral horizon by the weathering of rocks, but in this layer, the "recycling by roots is not nearly as strong". When you lower the root available calcium levels, which we saw in the 1970s, the soil loses its ability to buffer harmful elements, the pH of the soil decreases, and mobilization of aluminum begins which is very detrimental to trees [3].

Fish and other aquatic organisms

Acid rain initiates a series of detrimental effects on fish, leading to harm or mortality at the individual level, a decrease in fish population numbers, the complete elimination of fish species from water bodies, and a reduction in overall biodiversity. As acid rain moves through the soils within a watershed, it releases aluminum into lakes and streams situated in that area. Consequently, as the pH of a lake or stream decreases, the levels of aluminum rise. Both low pH and elevated aluminum levels pose direct toxicity to fish. Furthermore, these conditions induce chronic stress, which may not

necessarily result in the immediate death of individual fish but leads to reduced body weight and smaller size, making fish less competitive for food and habitat [4].

While certain types of plants and animals can endure acidic waters, others are sensitive to acidity and face loss as pH levels decrease. Generally, the young of most species prove more susceptible to environmental conditions than adults. For instance, at pH 5, the majority of fish eggs fail to hatch, and at even lower pH levels, some adult fish may perish. In some instances, lakes affected by acid rain may lack fish altogether. The variation in acid tolerance is evident in the chart below, highlighting that not all fish, shellfish, or the insects they rely on for sustenance can tolerate the same degree of acidity. For example, frogs exhibit a higher tolerance to more acidic water (lower pH) compared to trout [4].

Solutions to acid rain

Acid deposition negatively effects soils, trees, plants, streams, lakes, coastal waters, human structures and human health. There are several solutions to the problem of acid rain, ranging from individual actions to government policies. One of the most effective ways to reduce acid rain is to reduce the emission of pollutants into the atmosphere. This can be achieved through the use of clean energy sources such as wind, solar, and hydroelectric power, as well as through the implementation of stricter regulations on emissions from factories and transportation [5].

Individual actions can also make a difference in reducing the impact of acid rain. Simple measures such as reducing energy consumption, using public transportation or carpooling, and properly disposing of hazardous materials can help reduce the emission of pollutants into the atmosphere. Furthermore, reforestation and afforestation programs can help absorb some of the pollutants in the atmosphere, as trees absorb carbon dioxide and other pollutants while releasing oxygen [5].

In addition to reducing emissions and individual actions, restoration programs can help restore ecosystems damaged by acid rain. These programs may include liming, which involves the addition of lime to soil or water to neutralize the acidity, or the introduction of plants and animals that are resistant to acidic conditions [5].

Conclusions

Acid rain stands as a global concern with numerous detrimental effects on the environment. The primary causes of acid rain are human activities, including the combustion of fossil fuels, industrial processes, and transportation. Its widespread environmental impacts call for solutions such as the reduction of pollutant emissions, individual initiatives, reforestation, and restoration programs. Various strategies have been employed globally to mitigate acid rain and its environmental consequences. Raising awareness and implementing policies can contribute to diminishing the effects of acid rain. The utilization of advanced, cost-effective, and reliable technologies may also play a role in reducing acid deposition. Governments can enact stricter policies concerning the emission of sulfur dioxide and nitrogen oxide from both transportation and industrial sources. It is our collective responsibility to take action, addressing this issue to safeguard our planet and its inhabitants. Through the implementation of effective solutions, we can mitigate the impact of acid rain and ensure the preservation of ecosystems for the well-being of future generations.

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Կիշլյանիու Ա-Մ. Վ., Պրիսեքարու Վ.Ա., Ալեմորյանու Ս.Ռ.

Սույն հոդվածում անդրադարձ է կատարվել թթվային անձրևների թեմային, որոնք լուրջ վտանգ են ներկայացնում շրջակա միջավայրի համար: Հիմնավորվում է այն միտքը, որ մթնոլորտում որոշակի թթու առաջացնող միացությունների առկայությունը, առաջին հերթին ծծմբի և ազոտական թթուների, որոնք առաջացել են ծծմբի, ազոտի օքսիդների և մթնոլորտային ջրային գոլորշիների հետ քիմիական փոխազդեցության արդյունքում, կարող է հանգեցնել անձրևաջրերի թթվայնացմանը: Նշվում է, որ թթվային անձրևների և էկոհամակարգի տարրերի փոխազդեցությունը հանգեցնում է կենսոլորտում տեղի ունեցող հավասարակշռության գործընթացների խախտմանը: Զգալի ուշադրություն է դարձվում թթվային տեղումների հետևանքով հողի բերրիության նվազեցմանը, ինչը հանգեցնում է հողից կենսական նշանակություն ունեցող բուսական նյութերի անկալահանումը, ինչն, ի վերջո հանգեցնում է անտառների դեգրադացիային: Հոդվածում վերլուծվում է նաև թթվային տեղումների և նյութերի բնական շրջապտույտի խախտման հետևանքով թթվային տեղումների վնասակար ազդեցությունը փակ ջրավազանների (բուսական, կենդանական աշխարհ) բիոցենոզների վրա: Ընդգծվում է, որ թթվային անձրևների հետևանքով առաջացած խախտումը ունենալու բացասական ազդեցությունը, տարածվում է էկոհամակարգի տարբեր աբիոտիկ և բիոտիկ բաղադրիչների վրա: Հոդվածը նպատակ է հետապնդում վերլուծել թթվային անձրևների ծագման և բացասական հետևանքների ուսումնասիրությունները, ինչպես նաև տալ շրջակա

միջավայրի վրա թթվային անձրևների բացասական ազդեցության դեմ պայքարի արդյունավետության գնահատականը:

Բանալի բառեր. *թթվային անձրևներ, անտառներ, բույսեր, հողեր, հետևանքներ:*

ВЛИЯНИЕ КИСЛОТНЫХ ДОЖДЕЙ НА ОКРУЖАЮЩУЮ СРЕДУ

Кышляниу А-М. В., Присэкару В.А., Алэморяну С.Р.

В статье затрагивается тема кислотных дождей, которые представляют собой серьезную угрозу для окружающей среды. Обосновывается мысль о том, что присутствие в атмосфере определенных кислотообразующих соединений, в первую очередь серной и азотной кислот, образующихся в результате химического взаимодействия оксидов серы и азота с атмосферными водяными парами, может привести к подкислению дождевой воды. Отмечается, что взаимодействие кислотных дождей и элементов экосистемы приводит к нарушению равновесных процессов протекающих в биосфере. Значительное внимание уделяется снижению плодородия почвы в результате выпадения кислотных осадков приводящих к выщелачиванию из почвы жизненно необходимых растительных веществ и в конечном счете вызывающих деградацию лесов. Вследствие выпадения кислотных осадков и нарушения природного круговорота веществ, в статье также анализируется пагубное влияние закисленных осадков на биоценозы замкнутых водоемов (флора, фауна). Подчеркивается, что нарушение вызванное кислотными дождями, негативно воздействуя, распространяется на различные абиотические и биотические компоненты экосистемы. Целью статьи является анализ изучения происхождения и негативных последствий кислотных дождей, а также оценка усилий по мерам борьбы с негативным влиянием кислотных дождей на окружающую среду.

Ключевые слова: *кислотные дожди, леса, растения, почва , последствия.*

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