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The Chemical Causes and Social Effects of Acid Rain

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National Geographic recently wrote an article about acid rain. Acid rain is one of the biggest ecological stressors our planet faces today. Despite the hugely deleterious effects that acid rain has been proven to have, efforts to curb its harmful effects have not been wholeheartedly accepted by the public. These efforts come all the way from national governments and international organizations, both of which sing the praises of alternative fuels as a necessary good to remedy the harmful effects of acid rain.[2] Unfortunately, as the authors write, humanity seems to prefer its current activities that are damaging the planet over the clean alternatives. The battle against acid rain will be long and hard, especially when considering that even if all activities that proliferate acid rain ended today, the accumulated effects of acid rain would persist for years throughout the generations. As such, this paper will discuss the chemistry behind acid rain and the social consequences of its incidence with the aforementioned *National Geographic* article as a reference point.

National Geographic aims to be informative and persuasive without resorting to propaganda in its article. The article brings up some basic facts about what acid rain is and how it harms many different kinds of organisms and ecosystems. It also goes on to talk about answers to the acid rain problem, including alternative fuel options. Apart from that, *National Geographic* tells readers what they can do to help the cause, including limiting fossil fuel emissions through car-pooling and walking.[2] However, it should be noted that this article is not purely scientific because it discusses how governments are trying to advertise acid rain as a serious threat to humanity that must be dealt with. Unfortunately, their spinning is not met with enough policy nor incentive to follow through with limiting fossil fuel emission, so the general public has not truly embraced these policies.

Before talking about acid rain as a grand concept, the idea of acidity should be touched upon. According to the Arrhenius interpretation, a substance is acidic if it has an acidic hydrogen component and if it yields H_3O^+ in water. According to the Lewis interpretation, a substance is acidic if it can accept an electron from a donor substance. Acidity can cause substances to have a sour taste, as seen in lemons or vinegar. Acids will have a pH value of less than seven. Particularly strong acids can be remarkably corrosive and dangerous to work with.[3] A good example of such a strong acid is gastric acid, which is a combination of hydrogen chloride, potassium chloride, and sodium chloride. Gastric acid turns on digestive enzymes that aid in the digestion of proteins. Even though acids can be dangerous to human beings, they are also integral to our survival.

Now that acidity has been discussed, the topic acid rain can now be further explored by this article. Before further discussion, acid rain should be defined as precipitation with exorbitant amounts of constituent nitric and sulfuric acids. It

should be noted that although acid rain is the most commonly discussed acidic precipitation, this phenomenon can manifest itself as snow, fog, etc. Human beings aid and abet the perpetuation of acid rain on Earth due to our relationship with fossil fuels. Due to various forms of transportation that require fossil fuels to be burned, people willingly add huge concentrations of sulfur dioxide and nitrogen dioxide into the planet's atmosphere. [1] These two compounds are necessary components of acid rain, so the burning of fossil fuels adds to the potential and concentration of acid rain. When mixed with the water in the atmosphere, these gases create nitric acid and sulfuric acid, and then once rainfall occurs, acidic compounds are being disseminated onto our planet.

Once acid rain falls to Earth, its effects are staggering. Runoff water with the acid rain component to it will fall into the soil. As plants take up the water with the nitric acid and sulfuric acid components within it, their internal defense mechanisms are severely crippled. Acid rain runoff leads to the spreading of aluminum ions. These ions are then taken up by plants, particularly trees, and cause a non-response effect in the trees in regards to their winter-hardening process. [2] This process is what girds trees against the temperature drop during winter, but without it, water that trees need to transport throughout their systems freezes and is unable to nourish the tree, resulting in the death of the plant.

As mentioned earlier, one of the ways in which scientists recognize substances that are acids is through the measuring tool known as pH, calculated by the equation $pH= -\log[H_3O^+]$.[3] If a substance has a pH below seven, then it is known as an acid. Acid rain, contrary to popular belief, however, is not any instance of precipitation with a pH below seven. Normal rainfall, for example, typically has a pH of around 5.6. Normal rain has a slight acidity due to the fact that the water reacts with the carbon dioxide in the environment, which in turn leads to the formation of carbonic acid. To be considered to be acid rain, the precipitation must have a pH value of under 5.0. Such an acidity can alter growth mechanisms in plants by creating false internal environments that either proliferate or mitigate signals that the plant's internal systems interpret as a necessity for a release of any number of growth hormones, and also destroy aquatic eggs, leading to the prenatal death of aquatic organisms.[1]

The aforementioned death of aquatic life has to do with acid rain lowering the pH of the water environments in which these organisms reside in. Acid rain lowers the pH of these systems through runoff from soil. The acid rain overcomes the soil's buffering capacity, which is essentially how much acidity the soil can resist before experiencing a change in pH. Acid rain can bring the pH of water within the soil down below 5.0, and as it runs into bodies of water as runoff, numerous forms of aquatic life are killed due to an inability to cope with such a strong acidity.[2]

Nowadays, most people and media obsess over the effects of global warming. This is justified due to the enormous impact that global warming has on the entire planet. However, it is important to note that acid rain is transboundary as well. It kills plant and aquatic life and creates an acid environment in water that is not safe for humans to associate with. Coincidently, many of the activities to combat global warming, like limiting fossil fuel emission, can help in mitigating the effects of acid rain as well. If humanity starts to take alternative fuels and eco-friendly methods of transportation seriously, the effects of global warming and acid rain can be brought down to a tolerable degree.

References

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