International Research Journal of Natural and Applied Sciences
ISSN: (2349-4077)
Impact Factor 5.46 Volume 4, Issue 11, November 2017
Website- www.aarf.asia, **Email** : editor@aarf.asia , editoraarf@gmail.com

ACID RAIN EFFECTS ON ANIMALS AND PLANTS: A STUDY

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ABTRACT

Acid rain damages the leaves of trees and plants, thus limiting their growth and exposing them to the metals in the air from the toxic rain. Depending on the severity of the damage, the vegetation can be stunted in its growth or the foliage can be stripped away. The damage can also destroy a plant's ability to handle cold or disease, which can also negatively impact the food web. Acid rain damages the leaves of trees and plants, thus limiting their growth and exposing them to the metals in the air from the toxic rain. Depending on the severity of the damage, the vegetation can be stunted in its growth or the foliage can be stripped away. The damage can also destroy a plant's ability to handle cold or disease, which can also negatively impact the food web. When acid rain absorbs into the ground, the soil becomes more acidic, which dissolves helpful minerals in the soil. Acid rain also releases toxic substances, such as aluminum, into the soil and has poisonous effects. The effect of acid rain on plants and animals can be mitigated under certain conditions, such as having a thick layer of soil and having certain types of bedrock under the soil to absorb the rain. When fish are exposed to acid rain, the disturbed levels of minerals in fish will affect their reproductive system and the females will not release eggs. When certain fish are in water with a very acidic pH level, the mucus on their gills will become very sticky and will eventually stick together, causing them to be unable to receive oxygen from the water.

INTRODUCTION

Acid rain is a rain or any other form of precipitation that is unusually acidic, meaning that it has elevated levels of hydrogen ions (low pH). It can have harmful effects on plants, aquatic animals, and infrastructure. Acid rain is caused by emissions of sulfur dioxide and nitrogen oxide, which react with the water molecules in the atmosphere to produce acids. Some governments have made efforts since the 1970s to reduce the release of sulfur dioxide and nitrogen oxide into the atmosphere with positive results. Nitrogen oxides can also be produced naturally by lightning strikes, and sulfur dioxide is produced by volcanic eruptions. Acid rain has been shown to have adverse impacts on forests, freshwaters, and soils, killing insect and aquatic life-forms, causing paint to peel, corrosion of steel structures such as bridges, and weathering of stone buildings and statues as well as having impacts on human health.

LITERATURE REVIEW

- Anita Singh and Madhookia Agarwal have shown the effect of acid rain and its ecological effects (Singh & Agrawal, 2008). Haradhan Kumar Mohajan has discussed SO2 emissions in China. He also enlightens aspects of SO2 and its reduction policies in China (Mohajan, 2014). Y. Somu Naidu and C. Kavitha have analyzed the data of the average annual pH, electrical conductivity, and SO4, NO3, NH4 and Ca of rain waters for Visakhapatnam of India over a period from 1983 to 2005. They have found alarming acidic nature of rainwater in the industrial zone of that city (Naidu &Kavitha, 2012).

- Y. F. Fan, Z. Q. Hu, and H. Y. Luan have evaluated the tensile properties of concrete exposed to acid rain environment. They have examined the voids, micro cracks, chemical compounds, elemental distribution, and contents in the concrete (Fan et al., 2012). Richard A. Livingston has stressed that acid rain damages the cultural heritage, particularly outdoor marble and bronze sculptures (Livingston, 2016). Aadit Gandhi, Parth Patel, and GirishBagale have discussed the ecological effects of acid rain in streams, lakes, and marshes. They observe that acid rain also damages man-made materials and structures. They have found that human activities, such as combustion of burnable waste, fossil fuels in thermal power plants and automobiles are the main causes of acid rain (Gandhi et al., 2017).

- Thomas V. El-Mallakh, YonglinGao, and Rif S. El-Mallakh have examined the effect of simulated acid rain on the root systems of a common tropical vine (El-Mallakh et al., 2014). Fredric C. Menz and Hans M. Seip have discussed the evolution of science and acid rain control policies, the costs and benefits of reducing acid rain in Europe and the USA over the past several decades (Menz&Seip, 2004). Douglas Burns, Julian Aherne, and David Gay have analyzed that acid rain causes the acidification of surface waters and toxic effects on vegetation, fish, and another biota. They have observed that acid rain affects North America and Europe, and later affects China and some other Asian countries (Burns et al., 2016).

- Yinjun Zhang, Qian Li, Fengying Zhang, and GaodiXie reveal that China is facing the severe acid problem which causes economic loss, corrosion, and damage to materials, and the reduction of material lifespan (Zhang et al., 2017). Duan et al. (2016) have studied acid deposition its environmental effects across Asia. They have observed that sulfur deposition has decreased in recent years but nitrogen deposition is increasing in Asia and becomes a major threat in Eastern Asia. I. M. Hilmi, K. Susilawati, O. H. Ahmed, and Nik M. Majid
- 5 have identified that rapid industrialization and unsustainable agricultural practices are some of the possible causes of acid rain in Malaysia (Hilmi et al.,2013)

EFFECTS ON HUMAN HEALTH AND HUMAN ENVIRONMENTS

The pollutants that cause acid rain also damage human health. These gases interact in the atmosphere to form fine sulfate and nitrate particles that can be inhaled deep into the lungs. Scientific studies show relationships between elevated levels of fine particles and increased illness and premature death from heart disease and lung disorders, such as bronchitis. In addition, nitrogen oxides react in the atmosphere to form **ozone** , increasing risks associated with lung inflammation, such as asthma. **Sulfates** and nitrates in the atmosphere also contribute to reductions in visibility. Sulfate particles account for 50 to 70 percent of decreased visibility in eastern U.S. national parks, such as the Shenandoah and the Great Smoky Mountains. In the western United States, nitrates and carbon also play roles, but sulfates have been implicated as an important source of visibility impairment in some national parks, such as the Grand Canyon. Wet and dry acid deposition contribute to the corrosion of metals (such as bronze) and the deterioration of paint and stone (such as marble and limestone). These effects seriously reduce the value to society of buildings, bridges, cultural objects (such as statues, monuments, and tombstones), and automobiles.

SURFACE WATERS AND AQUATIC ANIMALS

Not all fish, shellfish, or the insects that they eat can tolerate the same amount of acid; for example, frogs can tolerate water that is more acidic (i.e., has a lower pH) than trout.Both the lower pH and higher aluminium concentrations in surface water that occur as a result of acid rain can cause damage to fish and other aquatic animals. At pH lower than 5 most fish eggs will not hatch and lower pH can kill adult fish. As lakes and rivers become more acidic biodiversity is reduced. Acid rain has eliminated insect life and some fish species, including the brook trout in some lakes, streams, and creeks in geographically sensitive areas, such as the Adirondack Mountains of the United States.However, the extent to which acid rain contributes directly or indirectly via runoff from the catchment to lake and river acidity (i.e., depending on characteristics of the surrounding watershed) is variable. The United States Environmental Protection Agency's (EPA) website states: "Of the lakes and streams surveyed, acid rain caused acidity in 75% of the acidic lakes and about 50% of the acidic streams". Lakes hosted by silicate basement rocks are more acidic than lakes within limestone or other basement rocks with a carbonate composition (i.e. marble) due to buffering effects by carbonate minerals, even with the same amount of acid rain.

SOILS

Soil biology and chemistry can be seriously damaged by acid rain. Some microbes are unable to tolerate changes to low pH and are killed. The enzymes of these microbes are denatured (changed in shape so they no longer function) by the acid. The hydronium ions of acid rain also mobilize toxins, such as aluminium, and leach away essential nutrients and minerals such as magnesium.

$$2\,H^{+}\,(aq) + Mg^{2+}\,(clay) \rightleftharpoons 2\,H^{+}\,(clay) + Mg^{2+}\,(aq)$$

Soil chemistry can be dramatically changed when base cations, such as calcium and magnesium, are leached by acid rain, thereby affecting sensitive species, such as sugar maple (Acer saccharum).

SOIL ACIDIFICATION

Impacts of acidic water and Soil acidification on plants could be minor or in most cases major. Most minor cases which do not result in fatality of plant life can be attributed to the plants being less susceptible to acidic conditions and/or the acid rain being less potent. However, even in minor cases, the plant will eventually die due to the acidic water lowering the plant's natural pH. Acidic water enters the plant and causes important plant minerals to dissolve and get carried away; which ultimately causes the plant to die of lack of minerals for nutrition. In major cases, which are more extreme, the same process of damage occurs as in minor cases, which is removal of essential minerals, but at a much quicker rate. Likewise, acid rain that falls on soil and on plant leaves causes drying of the waxy leaf cuticle, which ultimately causes rapid water loss from the plant to the outside atmosphere and eventually results in death of the plant. To see if a plant is being affected by soil acidification, one can closely observe the plant leaves. If the leaves are green and look healthy, the soil pH is normal and acceptable for plant life. But if the plant leaves have yellowing between the veins on their leaves, that means the plant is suffering from acidification and is unhealthy. Moreover, a plant suffering from soil acidification cannot photosynthesize; the acid-water-induced process of drying out of the plant can destroy chloroplast organelles. Without being able to photosynthesize, a plant cannot create nutrients for its own survival or oxygen for the survival of aerobic organisms, which affects most species on Earth and ultimately ends the purpose of the plant's existence

FORESTS AND OTHER VEGETATION

Adverse effects may be indirectly related to acid rain, like the acid's effects on soil (see above) or high concentration of gaseous precursors to acid rain. High altitude forests are especially vulnerable as they are often surrounded by clouds and fog which are more acidic than rain.Other plants can also be damaged by acid rain, but the effect on food crops is minimized by the application of lime and fertilizers to replace lost nutrients. In cultivated areas, limestone may also be added to increase the ability of the soil to keep the pH stable, but this tactic is largely unusable in the case of wilderness lands. When calcium is leached from the needles of red spruce, these trees become less cold tolerant and exhibit winter injury and even death

ROLE OF NITROGEN IN ACID RAIN AND OTHER ENVIRONMENTAL PROBLEMS

The impact of nitrogen on surface waters is also critical. Nitrogen plays a significant role in episodic acidification and new research recognizes the importance of nitrogen in long-term chronic acidification as well. Furthermore, the adverse impact of atmospheric nitrogen deposition on estuaries and near-coastal water bodies is significant. Scientists estimate that 10 to 45 percent of the nitrogen produced by various human activities that reaches estuaries and coastal ecosystems is transported and deposited via the atmosphere. For example, about 30 percent of the nitrogen in the Chesapeake Bay comes from atmospheric deposition. Nitrogen is an important factor in causing eutrophication (oxygen depletion) of water bodies. The symptoms of eutrophication include blooms of algae (both toxic and non-toxic), declines in the health of fish and shellfish, loss of seagrass beds and coral reefs, and ecological changes in food webs. According to the National Oceanic and Atmospheric Administration (NOAA), these conditions are common in many of our nation's coastal ecosystems. These ecological changes impact human populations by changing the availability of seafood and creating a risk of consuming contaminated fish or shellfish, reducing our ability to use and enjoy our coastal ecosystems, and causing economic impact on people who rely on healthy coastal ecosystems, such as fishermen and those who cater to tourists.

ACID RAIN AFFECT FISH AND OTHER AQUATIC ORGANISMS

Acid rain causes a cascade of effects that harm or kill individual fish, reduce fish population numbers, completely eliminate fish species from a waterbody, and decrease biodiversity. As acid rain flows through soils in a watershed, aluminum is released from soils into the lakes and streams located in that watershed. So, as pH in a lake or stream decreases, aluminum levels increase. Both low pH and increased aluminum levels are directly toxic to fish. In addition, low pH and increased aluminum levels cause chronic stress that may not kill individual fish, but leads to lower body weight and smaller size and makes fish less able to compete for food and habitat.Some types of plants and animals are able to tolerate acidic waters. Others, however, are acid-sensitive and will be lost as the pH declines. Generally, the young of most species are more sensitive to environmental conditions than adults. At pH 5, most fish eggs cannot hatch. At lower pH levels, some adult fish die. Some acid lakes have no fish. The chart below shows that not all fish, shellfish, or the insects that they eat can tolerate the same amount of acid; for example, frogs can tolerate water that is more acidic (i.e., has a lower pH) than trout.

CONCLUSION

Acid rain can be stopped in several ways. As well as governments' role in focusing on more sustainable energy sources, such as solar, wind and water energy, and putting restrictions on the use of fossil fuels, we people play a key role in reducing acid rain emissions. The biggest step to prevent acid rain is to conserve energy. Simply shutting off electrical appliance Whenever you're not using them is a good start. You can also help reducing auto emissions by using public transport or carpooling as well as riding bikes or even walking to near destinations.Power plants need to do their part as well. Washing coal to remove some of the sulfur or using coal comprised of low sulfur are some actions they can do. They can also use devices called scrubber. They are capable of removing the sulfur dioxide from gases leaving the smokestack.

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