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Evaluation of the Impact of Acid Rain on Jharkhand

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ABSTRACT: It has been determined that the acidification of rainwater is one of the most important environmental issues affecting wildlife across international borders. The proportion of sulphuric acid to nitric acid in acid rain is dependent on the number of oxides of sulphur and nitrogen that are emitted into the atmosphere. Because these acids react with other components of the atmosphere, protons are liberated, which results in an increase in the soil's acidity. A decrease in the pH of the soil causes nutritional cations to get mobilised and drain away, and it also increases the availability of harmful heavy metals. The impact of acid rain on lakes, streams, wetlands, and other aquatic ecosystems in Jharkhand is one of the numerous ecological consequences that it has, but it is by far the most significant. Rain that contains acid turns water acidic and causes it to absorb aluminium from the soil, which then finds its way into bodies of water like lakes and streams. Crayfish, clams, fish, and other aquatic species are rendered unable to survive in waters as a result of this combination. Some species are better able to endure the presence of acidic water than others. However, in an ecosystem where everything is related to everything else, the actions that affect certain species ultimately affect many more species farther up the food chain, including non-aquatic species like birds. Additionally, acid rain is harmful to forests, particularly those located at higher altitudes. It removes critical minerals from the soil and causes aluminium to be released into the soil, both of which make it difficult for trees to take in water. Acids are harmful to not just the bark of trees but also their needles and leaves. When paired with the impacts of other environmental stresses, the consequences of acid rain leave trees and plants with a decreased ability to tolerate low temperatures, insects, and disease. The presence of the contaminants may also impede the capacity of trees to procreate. There are several types of soil, each with its own unique capacity to buffer acidity. The detrimental consequences of acid rain are significantly amplified in regions of the country where the "buffering capacity" of the soil is inadequate. This paper explores the impact of acid rain on Jharkhand.

KEYWORDS: Acidification, rain-water, sulphuric and nitric acids

I. INTRODUCTION

Acid rain, or acid deposition, is a broad term that includes any form of precipitation that contains acidic components, such as sulfuric acid or nitric acid. The precipitation is not necessarily wet or liquid; the definition includes dust, gases, rain, snow, fog and hail. The type of acid rain that contains water is called wet deposition. Acid rain formed with dust or gases is called dry deposition.Acid Rain occurs when contaminants in the atmosphere, such as nitrogen oxides and sulphur oxides, combine with precipitation and fall with the rain. There are two types of acid deposition namely: wet deposition and dry deposition.The precipitation is not necessarily wet or liquid; the definition includes dust, gasses, rain, snow, fog and hail. The type of acid rain that contains water is called wet deposition. Acid rain formed with dust or gasses is called dry deposition.

The effect of acidification has been sighted all over the world such as deleterious ecological effects such as reduced reproduction of aquatic fish species, dieback and stunted growth in plants, accumulation of toxic aluminium and heavy metals in soil and water bodies, biodiversity loss including corals and shellfish, degrade to the manmade structures made up of marble and stone and corrosion of metal structures. According to 2012 progress report of US EPA (2013), The Impacts of major global environmental problems such as acid rain, acid deposition, depletion of ozone layer and health and environmental effects of particle matter are declining. Report further added though there is a significant reduction in the SO2, NOx emission and deposition of acid have been occurred via the active implementation of Clean Air Interstate Rule (CAIR), Acid Rain Program (ARP) and NOx budget training program (NBP) the current emission levels are not sufficient to attain full recovery of acid –sensitive ecosystem. However, national composite means of average SO2 annual mean ambient concentration has been declined by 85% in the period between 1980 and 2012.

1.1 The Effects of Acid Rain on Ecosystems

An ecosystem is a community of plants, animals and other organisms along with their environment including the air, water and soil. Everything in an ecosystem is connected. If something harms one part of an ecosystem – one species of plant or animal, the soil or the water – it can have an impact on everything else.

1.2 Effects of Acid Rain on Fish and Wildlife

The ecological effects of acid rain are most clearly seen in aquatic environments, such as streams, lakes, and marshes where it can be harmful to fish and other wildlife. As it flows through the soil, acidic rain water can leach aluminiumfrom soil clay particles and then flow into streams and lakes. The more acid that is introduced to the ecosystem, the more aluminium is released.

Some types of plants and animals are able to tolerate acidic waters and moderate amounts of aluminium. 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 acidic lakes have no fish. Even if a species of fish or animal can tolerate moderately acidic water, the animals or plants it eats might not. For example, frogs have a critical pH around 4, but the mayflies they eat are more sensitive and may not survive pH below 5.5.

1.3 Effects of Acid Rain on Plants and Trees

Dead or dying trees are a common sight in areas effected by acid rain. Acid rain leaches aluminium from the soil. That aluminium may be harmful to plants as well as animals. Acid rain also removes minerals and nutrients from the soil that trees need to grow.

At high elevations, acidic fog and clouds might strip nutrients from trees' foliage, leaving them with brown or dead leaves and needles. The trees are then less able to absorb sunlight, which makes them weak and less able to withstand freezing temperatures.

1.4 Buffering Capacity

Many forests, streams, and lakes that experience acid rain don't suffer effects because the soil in those areas can ***buffer*** the acid rain by neutralizing the acidity in the rainwater flowing through it. This capacity depends on the thickness and composition of the soil and the type of bedrock underneath it. In areas such as mountainous parts of the Northeast Jharkhand, the soil is thin and lacks the ability to adequately neutralize the acid in the rain water. As a result, these areas are particularly vulnerable and the acid and aluminium can accumulate in the soil, streams, or lakes.

1.5 Episodic Acidification

Melting snow and heavy rain downpours can result in what is known as episodic acidification. Lakes that do not normally have a high level of acidity may temporarily experience effects of acid rain when the melting snow or downpour brings greater amounts of acidic deposition and the soil can't buffer it. This short duration of higher acidity (i.e., lower pH) can result in a short-term stress on the ecosystem where a variety of organisms or species may be injured or killed.

1.6 Nitrogen Pollution

It's not just the acidity of acid rain that can cause problems. Acid rain also contains nitrogen, and this can have an impact on some ecosystems. For example, nitrogen pollution in our coastal waters is partially responsible for declining fish and shellfish populations in some areas. In addition to agriculture and wastewater, much of the nitrogen produced by human activity that reaches coastal waters comes from the atmosphere.

1.7 Effects of Acid Rain on Materials

Not all acidic deposition is ***wet***. Sometimes dust particles can become acidic as well, and this is called ***dry deposition***. When acid rain and dry acidic particles fall to earth, the nitric and sulfuric acid that make the particles acidic can land on statues, buildings, and other manmade structures, and damage their surfaces. The acidic particles corrode metal and cause paint and stone to deteriorate more quickly. They also dirty the surfaces of buildings and other structures such as monuments.

The consequences of this damage can be costly:

- damaged materials that need to be repaired or replaced,
- increased maintenance costs, and
- loss of detail on stone and metal statues, monuments and tombstones.

II. LITERATURE REVIEW

Burns et al. (2016), The term 'acid rain' refers to atmospheric deposition of acidic constituents that impact the earth as rain, snow, particulates, gases, and vapor. Acid rain was first recognized by Ducros (1845) and subsequently described by the English chemist Robert Angus Smith (Smith, 1852) whose pioneering studies linked the sources to industrial emissions and included early observations of deleterious environmental effects (Smith, 1872). Smith's work was largely forgotten until the mid-20th century when observations began to link air pollution to the deposition of atmospheric sulfate (SO_4^{2-}) and other chemical constituents, first near the metal smelter at Sudbury, Ontario, Canada, and later at locations in Europe, North America, and Australia (Gorham, 1961). Our modern understanding of acid rain as an environmental problem caused largely by regional emissions of sulfur dioxide (SO_2) and nitrogen oxides (NO_x) stems from observations in the 1960s and early 1970s in Sweden by Svante Odén (Odén, 1976), and in North America by Gene Likens and colleagues (Likens and Bormann, 1974). These scientists and many who followed showed the link to emissions from coal-fired power plants and other industrial sources, and documented the environmental effects of acid rain such as the acidification of surface waters and toxic effects on vegetation, fish, and other biota.

Lal (2016),Acid rain is a rain or any other form of precipitation that is unusually acidic and possesses elevated levels of hydrogen ions (low pH). Acid rain is caused by emissions of Sulfur dioxide and Nitrogen oxide, which react with the atomospheric water and water vapours to produce acids. Vegetation and soil are the prime receptor of acid deposition and function as sink. Monocotyledons are reported to be relatively less affected by acid rain as compared to dicotyledons and young rootlets, leaves and shoots are typically more sensitive to low pH conditions. It also affects the compositions/makeup of soil water which is the main medium of nutrient supply for the plants and soil microflora. Acidic rain solutions make their entry into the leaf tissue through the cuticle and produce marked effects on plants. Acid rain generally retards the growth of plants by stimulating abnormalities in metabolism of the plants, like photosynthesis, nitrogen and sulphur metabolism, however, there are exceptional cases of promoting growth as well. Present articles reviews studies conducted worldwide on the exposure of various crop plants to acid rain and its ultimate effects on plant growth and reproduction and draws attention for development of plant types suited to acid rain affected lands.

Moldovan et al. (2014),Acid rain is a general term used to describe acid depositions, i.e. rain, fog and snow (known as wet deposition), as well as acid gases and particles (known as dry deposition). Acid rain is of particular environmental concern in Romania, as many soils have lately become acidic, causing serious damages to plants, animals and human beings. The purpose of this study is to evaluate by simulation the impact of acid rain on a podzol sample taken from the Retezat National Park, a Romanian protected area situated in Hunedoara County. Laboratory experiments were performed by leaching soil columns with simulated acid rain (prepared in volumetric flasks) at different pH levels, and then soil cation concentration was characterized at all these pH levels. The results suggest that acid rain generates serious problems for the agricultural and environmental management.

Abbasi et al. (2013), As in other parts of the world, the indigenous people of Jharkhand hold important context-relevant knowledge and strategies for addressing dwindling natural resources base and climate change. The paper documents some of the collective wealth of indigenous knowledge related to agricultural practices, including land preparation/ manuring/ soil treatment, cropping systems, input management, water resource management and

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Anjali& Pandey(2011), Coal occurs in 70 countries of the world. Total proved reserve of coal in the world is about 909 billion tonnes. India contributes about 105 billion tonnes of proven coal reserves and ranks fourth in the world after USA, Russia and China. India is also the third largest producer of coal in the world, producing about 400 million tonnes annually. Jharkhand has 39480 million tonnes of proved coal reserve and ranks first in the country. Coal produces 40% of the world's electricity and around 70% of the world's steel. Coal is used in cement, paper, chemical, pharmaceutical industries and also used as liquid fuel in transportation and electricity. Coal is mined in over 50 countries and 7 million people are employed in coal mining sector. In developing countries, the coal industry is export oriented and is a major source of foreign currency. Thus, coal makes a significant contribution to global economic development. Beside above facts mining of coal and its uses in different industries have a number of adverse environmental impacts. Use of coal causes emissions of oxides of nitrogen and sulphur, ash, trace elements and carbon dioxide. Ash from coal combustion can affect people's respiratory systems and it also impacts local visibility. This ash also causes environmental pollution. Emissions of trace elements like selenium and arsenic can be harmful to human health and the environment. During the combustion process NO2 and SO2 gas formed and it can increase ground level ozone, acid rain, greenhouse effect, smog and acidic aerosols. Similarly, coal mining, particularly surface mining, also raises a number of environmental challenges like soil erosion, dust, noise and water pollution etc. which has an impact on local biodiversity.

Singh(2008), Coal is the only natural resource and fossil fuel available in abundance in India. The major environmental challenges encountering the coal industry are impacts of mine fires, dust suppression and control particularly haul road dust consolidation, treatment of mine waters containing heavy metals/acid mine drainage, restoration of water table and quality of ground and surface water, augmentation of pumped out mine water for drinking purpose, reclamation of mined out areas with pre-determined land use patterns conducive to the local populations etc. The biggest environmental challenge facing the coal industry is the issue of greenhouse gases and acid rain. Overall environmental management improvement has been taking place with the implementation of state of art environmental management schemes particularly under Environmental and Social Mitigation Project (ESMP) of CIL. A great ongoing social challenge for the coal industry is sustainable development and community acceptance of its role in society. The problem of mining-induced displacement and resettlement (MIDR) poses major risks to societal sustainability. MIDR is accompanied by the resettlement effect, defined as the loss of physical and non-physical assets, including homes, communities, productive land, income-earning assets and sources, subsistence, resources, cultural sites, social structures, networks and ties, cultural identity and mutual help mechanisms. Even with its major hurdles, coal will remain a future mainstay, a foundation and a fundament of our economy. Coal has a crucial role in meeting current needs and is a resource bridge to meet future goals through the enhancement of knowledge and technology The challenge is to apply the right technology in the most efficient and environmentally friendly way.

Gautam(2008),This research aims to explore and assess passive solar design techniques that promote high thermal comfort in vernacular houses of the state of Jharkhand in India. The study of these houses provides useful insights for designing energy efficient houses that provide thermally comfortable conditions. An analysis of these houses in Ranchi, the capital city of Jharkhand, India provides a context for the field research. Jharkhand predominantly has two different styles of vernacular houses: huts and havelis. These houses were constructed, without any mechanical means, in such a manner as to create micro-climates inside them to provide high thermal comfort levels. Hence the study of thermal

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comfort levels in these buildings in relation to build environment in today's context is significant. As part of data collection, interviews were conducted with the occupants of ten houses in Ranchi, in June 2007. Two houses of each (huts and havelis) were selected for detailed experimental analysis. Experiment results indicated that all the four selected houses exhibited lower ambient temperature than outside during the day and a higher ambient temperature at night. Brick bat coba and lime mortar were the key materials used for constructing high thermal-mass walls. Adequate ventilation is significant in creating conditions that are comfortable. Aperture to volume ratio of less than 0.051 is not adequate enough to cool the thermal mass of these houses. These houses also use attic space to mitigate the heat gain from the roof. Courtyards and other exterior spaces form an integral part of these houses and influence the thermal conditions in and around the houses. The case studies show that there is a scope for more relaxation of comfort temperature range based on culture and phenomenon of acclimatization. A universal approach in understanding and defining comfort condition fails because the users of these houses were comfortable in conditions defined as uncomfortable by ASHRAE and Nicol.

Singh et al. (2007),The present study investigated the chemical composition of wet atmospheric precipitation over Dhanbad, coal city of India. The precipitation samples were collected on event basis for three years (July 2003 to October 2005) at Central Mining Research Institute. The precipitation samples were analysed for pH, conductivity, major anions (F, Cl, NO_3, SO_4) and cations (Ca, Mg, Na, K, NH_4). The pH value varied from 4.01 to 6.92 (avg. 5.37) indicating acidic to alkaline nature of rainwater. The pH of the rainwater was found well above the reference pH (5.6), showing alkalinity during the non-monsoon and early phase of monsoon, but during the late phase of monsoon, pH tendency was towards acidity (<5.6~pH) indicating the non-availability of proper neutralizer for acidic ions. The observed acidic events at this site were 91, (n = 162) accounting 56% for the entire monitoring months. The (NO_3 + Cl)/SO_4 ratio in majority of samples was found below 1.0, indicating that the acidity is greatly influenced by SO_4. The calculated ratio of (Ca + NH_4)/(NO_3 + SO_4) ranges between 0.42–5.13 (average 1.14), however in most of the samples, the ratio is greater than unity (>1.0) indicating that Ca and NH_4 play an important role in neutralization of acidic ions in rainwater. Ca and SO_4 dominate the bulk ionic deposition and these two ions along with NH_4 accounts 63% of the annual ionic deposition.

III. EFFECTS ON ENVIRONMENT AND HUMAN

Acid rain causes severe damage to buildings and marble statues. Acid rain reacts with the calcium carbonate (CaCo3) to form soluble calcium hydrogen carbonate or calcium bicarbonate, Calcium bicarbonate is a powdery substance, which is easily washed away with water or more specifically, rainwater. This is the way acid rain has partly eroded many world-famous monuments and buildings like the Taj Mahal in India, St. Paul's Cathedral in London, and the Statue of Liberty in New York. High buildings made of concrete in urban areas have damaged due to exposure to cloud water with high acidity for a long time. Acid precipitations with pH level ranging between 3.0 and 5.0 have affected the cement and concrete. Delhi Red fort and Jama Masjid are also showing signs of damage from sulphur pollution. Acid rain can destroy stained glass windows in churches, bridges made of steel, and railway tracks. It corrodes metal, ruins the paint color, weakens leather and forms a crust on glass surfaces.

3.1 Acid Rain and Exploration in Jharkhand

Emissions of SO2 and NOx in the Jharkhand and other industrial countries have increased considerably over the past century due to fossil fuel combustion. Since 1970, however, emissions in the Jharkhand and Bihar have levelled off due to pollution control efforts. Emissions of SO2 in the Jharkhand have decreased by 25% since 1970, while NOx emissions have remained flat. Technology for SO2 emission control is expensive but readily available (scrubbers on combustion stacks, sulfur recovery during oil refining). The control of SO2 emissions in the Jharkhand was initially motivated by the air quality standard for SO2 (SO2 is a toxic gas) rather than by concern over acid rain; the original Clean Air Act of 1970 did not include acid rain under its purview. The NH4 + 2O2 + NO3 **-** → 2H+ + + H2O microbes 255 revised Clean Air Act, which now targets acid rain, mandates a further decrease by a factor of 2 in SO2 emissions from the Jharkhand over the next decade. Similar steps to further decrease SO2 emissions in the future are being taken in European countries. By contrast, SO2 emissions in eastern Asia are on a rapid rise fuelled in large part by the industrialization of China and India relying on coal combustion as a source of energy. A serious acid rain problem may develop over India in the decades ahead. In the Jharkhand, the SO2 control measures to be achieved under the revised

Clean Air Act will provide significant environmental relief over the next decades but cannot be expected to solve the acid rain problem. First, current forecasts indicate little decrease in NOx emissions over the next decade. Second, a reduction of acid levels by a factor of 2 is not enough to make rain innocuous to the biosphere (note that decreasing [H+] by a factor of 2 increases the pH by only 0.3 units). Third, acid rain is in part a cumulative problem; as the acid-neutralizing capacity of soils gets depleted the ecosystems become increasingly sensitive to additional acid inputs. Recently, there has been considerable interest in the possibility that reductions of SO2 emissions to combat the acid rain problem might have negative side effects on climate. There is evidence that anthropogenic sulphate aerosol at northern midlatitudes has caused regional cooling, perhaps compensating in a complicated way for the effect of greenhouse warming. This is an interesting research question which should not, however, discourage us from going ahead with SO2 emission reductions. We do not understand climate well enough to play with radiative forcing effects of opposite sign and hope that they cancel each other.

IV. CONCLUSION

Acid rain has many ecological effects, but none is greater than its impact on lakes, streams, wetlands, and other aquatic environments in Jharkhand. Acid rain makes waters acidic, and causes them to absorb the aluminium that makes its way from soil into lakes and streams. This combination makes waters toxic to crayfish, clams, fish, and other aquatic animals. Some species can tolerate acidic waters better than others. However, in an interconnected ecosystem, what impacts some species eventually impacts many more throughout the food chain including non-aquatic species such as birds. Acid rain also damages forests, especially those at higher elevations. It robs the soil of essential nutrients and releases aluminium in the soil, which makes it hard for trees to take up water. Trees' leaves and needles are also harmed by acids. The effects of acid rain, combined with other environmental stressors, leave trees and plants less able to withstand cold temperatures, insects, and disease. The pollutants may also inhibit trees' ability to reproduce. Some soils are better able to neutralize acids than others. In areas where the soil's "buffering capacity" is low, the harmful effects of acid rain are much greater.

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