Review Article: 19 to 22 (2023)
ISSN: 2583-7419
biologyforum.actabotanica.org

Acid Rain and its Environmental Impact on Warri Municipal City

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Citation: Onuoha, T., Akpafun, A. S., Akpofure, I. H, R. S. Prathibha, Vedulla Madhavi (2023). Acid Rain and its Environmental Impact on Warri Municipal City. *Acta Biology Forum*. v020i1, **19-22. DOI:** http://dx.doi.org/ 10.5281/zenodo.7923007

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Received 18 October 2022 | Revised 29 December 2022 | Accepted 27 February 2023 | Available Online March 18 2023

ABSTRACT

Acid rain is a deposition of oxides of sulfur, carbon and nitrogen in the atmosphere and soil. It is a core contributory factor to global warming which is a major environmental problem in many parts of the world especially in Warri, Delta State municipal city. Acid rain occurs due to high levels of industrial activities like burning and production of fuel from fossil materials and other human activities. These have been attributed to the cause of air pollution, water pollution and environmental degradation which has led to the death of aquatic life and soil inhabitants including soil texture which eventually leads to building collapse. Studies have shown that Warri is home to acid rain as a result of the continual production of oil thus, it is called an oil city. The impact of acid deposition abound in the environment hence this paper review highlights the causes and effect on the environment with reference to ecobiota and housing quality in Warri urban centers. A study has shown that acid rain rose from 6 percent to 20 percent according to reports by National Environmental Management Agency (NEMA). This report is evident in the death and activities of ecobiota and soil texture which has led to building collapse and other negative effects caused by the presence of coal plant spewing sulfur dioxide and nitrogen oxides into the air turning clouds and rainfall acidic. This review recommends shifting from the reliance on fossil fuels to green energy sources; wind, solar and waves as measures to reduce the emission of sulfur dioxide and nitrogen oxides into the atmosphere as well as using building materials that are able to withstand the degrading effects of acid deposition for construction purposes and regular maintenance of buildings and structures to enhance their quality and aesthetic values as mitigation measures on the impact of acid deposition on the environment.

Keywords: Acid Rain, Environmental Impact, Municipal City, mitigation

INTRODUCTION

Acid rain is a deposition of oxides of sulfur, carbon and nitrogen in the atmosphere and soil. It is a core contributory factor to global warming which is a major environmental problem in many parts of the world (20).Sulfur dioxides and nitrogen oxides are gases that occur naturally in the Earth's atmosphere. These gases react with water, oxygen and other chemicals in the atmosphere to form various acidic compounds including mild sulfuric acid and nitric acid. In nature, the combination of rain and these oxides is part of a natural balance that nourishes plants and aquatic life forms. However, human activity increases the amount of acid -forming chemicals in the air. The result is harmful to humans and the environment (12). Acid rain is any form of precipitation (snow, frost, fog, mist) that contains high levels of nitric and sulfuric acids. It also occurs in dry form as dust or aerosols (tiny liquid droplets or solid particles). Winds can carry these acid-producing chemicals many kilometers from their source before they settle on landscape and where they enter streams and lakes as runoff and underground water flows (3). When gases especially sulfur and nitrogen oxides emitted by the burning of fossil fuels through natural and anthropogenic processes encounter clouds, the water vapor in the clouds combines with them to form acids which are returned to earth as acid rain or acid deposition. As a global environmental issue it is always overshadowed by climate change. Although, the problem of acid rain has been significantly reduced in some areas it remains an important environmental issue within industrial and agricultural regions. The evidence of acid rain in Nigeria has been a core problem over the years. For example, it was reported by (4) that acid rain rose from 6 percent in 2012 to 20 percent in 2020. This report is evident in the death and activities of ecobiota and soil texture which has led to building collapse and other negative effects caused by the presence of coal plant spewing sulfur dioxide and nitrogen oxides into the air turning clouds and rainfall acidic. As acid rain fell, it affected everything it touched leaching calcium from soils and robbing plants of important nutrients (5).

FORMATION OF ACID RAIN

A major component of acid rain is sulfur dioxide. When it reaches the atmosphere it oxidizes to form a sulfate ion first. It becomes sulfuric acid when it joins with hydrogen atoms in the air and falls back to earth. Most oxidation occurs in clouds especially in heavily polluted air where other compounds such

as ammonia and ozone helps to catalyze the reaction converting more sulphur dioxide to sulphuric acid. A substantial amount of sulfur dioxide can float up into the atmosphere can be transported to other locations and return to Earth unconverted. Nitric oxides and nitric dioxides are the other components of acid rain. They rise into the atmosphere and are oxidized in clouds to form nitric acid. These reactions are also catalyzed in heavily polluted clouds where iron, manganese, ammonia and hydrogen peroxide are present (6).

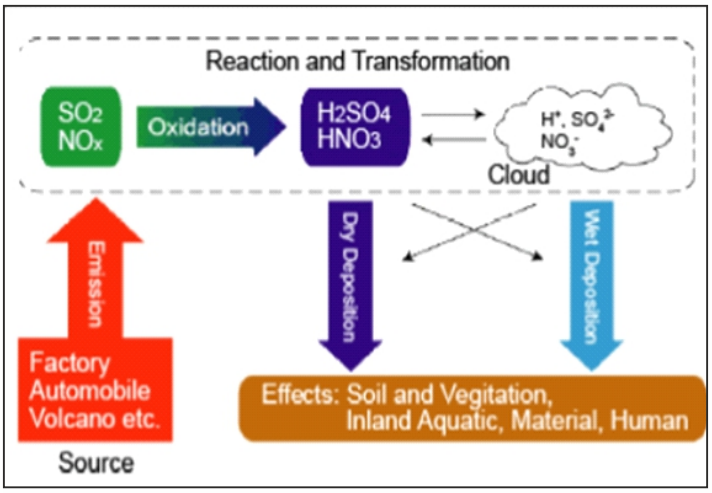


Figure 1: flow chart that shows the formation of acid rain and its interaction with the environment.
Source: (3)

Particulate matter is carried into the atmosphere where they mix with moisture and other pollutants to form dry and wet acid deposition. Wet deposition returns to earth as rain which enters water bodies. Percolate through soils or become run off into nearby water bodies. Dry deposition builds up over time on all dry surfaces to be transformed to water bodies in run off during periods of precipitation.

HOW DO WE MEASURE ACID RAIN

The acidity of precipitation is measured on a pH (potential Hydrogen) scale numbered from 0 to 14. It expresses the relative abundance of free hydrogen ions (H+) in a solution. These are what make acid corrosive for they easily combine with other ions. The pH scale is logarithmic i.e. every pH drop of one is a tenfold change, a pH of 7 is neutral i.e. neither acidic nor basic values, less than 7 are increasingly acidic and values greater than 7.0 are increasingly basic or alkaline. Although all rain water, tends to be acidic because of the equilibration of water with atmospheric carbon dioxide yielding a pH of 5.6-6.5. Precipitation with a pH below 5.0 is acidic, an indication of an increase in dissolved sulfur dioxide and nitrogen oxides in the rain water with serious consequences on the environment. The degree to which this phenomenon has impacted the study area (Warri and its environs) leaves much to be desired, as the effect of this phenomenon is seen on water surfaces, forests, and health and even on manmade structures among others (10).

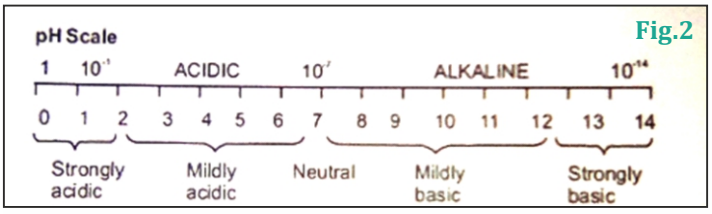


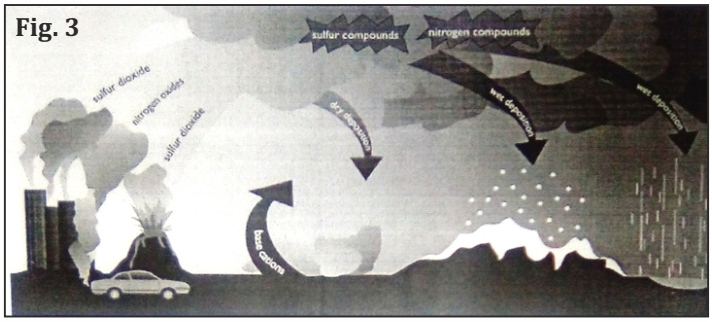
Fig.2

The pH scale
Source: (3)

The causes of acid rain

Acid rain is caused by the emission of sulphur dioxide and nitrogen oxides into the atmosphere by both natural and manmade (anthropogenic) sources. Natural sources of sulfate (sulfur oxides) emission in the atmosphere are ocean spray, volcanic eruptions and the decomposition of organic matter (plant and animal). Sources of nitrate emission include micro organisms in soils by lightening during thunder storms and forests fire (21). Manmade sources of emission includes the burning of fossil fuels (coal, oil and gas) for energy in the form of fossil- fueled electric utilities, industrial plants, motor vehicles using gasoline or diesel fuel and commercial and residential heating. Non- energy sources of emission of SO2 and NOX into the atmosphere includes metal smelter that emits sulfur and nitrogen oxides, agricultural fertilizers that are carried by wind to other areas. Levels of pollutants are measured in two ways; emission and concentration. Emission is those pollutants expelled into the air by a source. Concentration on the other hand is the total saturation of a contaminant over time. Acid rain can either be chronic or episodic. Chronic acidification is a long term effect due to many years of acid rain, while the episodic effect is due to heavy rain storms.

Fig. 3



Source: (11)

The primary problem with acid rain is that there is no way to contain it. The deterioration it causes to housing and other structures may be slow, but devastating and costly. Be that as it may, the issue of housing quality immediately comes to mind because acid rain first attacks the structure externally before exposing the structure to further damage be it physical or environmental. This negates the object of housing quality which is adequate protection of residents from cold, dampness, heat, rain, wind, structural hazards, diseases, vectors and other threat to human health internal and external as well as environmental concern (10). It is only in the last decades that attempts has been made to quantity the amount of damage that have been caused to buildings as a result of acid deposition. Concerns about the effect of acid rain on building materials were raised in the House of Commons select committee report in September 1984 in the UK. It is against this background that this paper seeks to examine acid rain and its impact on housing quality. It is necessary to do this so as to proffer solutions that will go a long way in reducing the effect acid rain have on housing quality in Warri. Warri being an industrial hub in the Niger Delta region, with a huge gas reserve with oil mining activities like drilling, oil spillage andgas flaring coupled with other natural sources enhances the emission of sulfur dioxides or nitrogen oxides into the atmosphere, thus acid mist and other forms of acid precipitation and its effects abound in the

study area. (8) in a study to compare the pH level of rain water in Warri and PortHacourt and that of Awka a non- oil producing area reveals that the average value for the onset of rain, mid-rain, and end of rain (April to June, July to August and September to October) for Warri in 2005 and 2006 are as follows; 4.81, 4.70, 6.15, and 4.79, 4.80, 4.72 as against the average pH value for Awka 6.04, 5.88, 5.75 and 6.00, 5.10, 5.96.

Table 1: pH of Rain Water Samples in Warri between April and October 2005 and 2006

Year	pH of Onset of Rain (April- June)	pH of Mid Rain (July –August)	pH of End of Rain (September – October)
2005	4.81 ± 0.026 (6.04 ± 0.013)	4.70 ± 0.017 (5.88±0.009)	6.15 ± 0.008 (5.75 ± 0.009)
2006	4.79 ± 0.006 (6.00 ± 0.006)	4.80 ± 0.056 (5.10 ±0.048)	4.72 ± 0.040 (5.96 ± 0.006)

Source; (10)

The Effects of Acid Rain on Housing Quality

It is evident that any industrialized region with power plants that burn fossil fuels will show some wear on its surrounding structures from acid rain. Acid rain damages most building materials used for the construction of buildings. Lime stone and marble dissolve in acid. The sand particles forming sand stone are often held together by calcium carbonate which dissolves in acid. Cement also reacts to acid rain because it is made up of calcium carbonate. Concrete buildings, sidewalks and art work made with cement show the effects of acid rain. Again, slabs of granite and other decorative materials are often held in place using cement. Due to acid rain, statue details disappear as the stones are washed away (19). The most vulnerable are limestone, marble, carbon steel, zinc, nickel, paint and some plastics. Stone decay can take several forms including the removal of detailed form, carved stone and the buildup of black gypsum crust in shattered areas. Acid rain can also corrode bronze and other metals such as nickel, zinc copper and carbon steel as evident by streaks and discoloration on bridges and other metal structures such as many commercial buildings. This is evidenced in decayed railings in most bridges and houses in Warri and its environs. Painting decoloration in most buildings in the study area is another effect of acid deposition. There are cases where soot (a black substance made of carbon) is found to coat structures around gas flaring sites. Plastic decoloration and decay is yet another effect as well as decay of corrugated iron sheets abound in the study area. The decay of facial boards and other decorations on buildings is another consequence of acid deposition. In addition to atmospheric attack structures that are submerged under acidified water such as foundations and pillars can also be corroded (17). Again not all buildings or structures suffer the effect of acid rain. It depends on the chemical makeup and interactions of a buildings material. Lime stone and marble which historically were used widely because of their availability and workability by artisans are especially susceptible because they are composed of calcium carbonate, which acidic chemicals can dissolve easily. Most structures and buildings are affected by acid deposition to some degree because few materials are free from these effects. This is evident in the study area as defects owing to deterioration by atmospheric pollution on the structures abound. This cumulates into cases of frequent maintenance that puts costs on house owners in the study area. An interesting positive effect of acid rain is that it had been found that it helps to reduce the production of methane – a more potent green house gas than carbon dioxide in wet land areas.

Fig. 5

Fig. 6

Building and statue affected by acid rain

Source: (16)

Measures to Mitigate the Impact of Acid Deposition on Housing

A wide variety of solutions to the problem of acid rain has been attempted ((15). These include the introduction of taller smokestacks in industries to push pollutants far into the atmosphere, increasing Lake Buffer capacity with the aid of lime, increasing the use of low sulfur coal to reduce Sox and NOX emission, removing suflur and nitrogen oxides from fuels and emission. As individuals, we can also reduce the impact of acid deposition by saving energy, conserving water and reducing the generation of waste products. Specific practices like mass transit, proper maintenance of vehicles and their pollution control device, better insulation of homes to make them more efficient for heating and cooling, installation of fluorescent lights and other energy - efficient appliances and turning them off when they are not in use as well as recycling and using recycled materials (13). Again, house owners can mitigate the environmental effects of acid rain on housing by using building materials that are better able to withstand the degrading effect of acid deposition. For instance, bitumen roof sheets are the best price roofing solution in the market that can withstand the impact of acid rain well aluminum roofing sheets. Again, the use of granite and sand stone composed of silicate minerals resist acid attacks from the atmosphere. Stainless steel and aluminum tend to also resist the effect of acid rain. House owners should monitor existing housing quality. They should also work with the government to avoid building code violations. Another measure to mitigate the impact of acid rain on housing is for government to provide assistance to owners of low- cost housing to rehabilitate structures that are in need of repairs so as to enhance their quality and aesthetics.

CONCLUSION

Acid rain is one of the world's environmental issues. Coal burning, vehicular and various fossil fuel- based power generation emit Sulfur dioxide and nitrogen oxides. This produces sulfuric and nitric acids which react with atmospheric water vapor and precipitate as acid rain. Acid rain affects structures and home. Its destructive signs on metals and stone components in the exteriors of homes abound in Warri. It also affects forest trees, rivers and lakes; it causes fish death and affects soil micro-organisms which cause increased nitrification which leads to eutrophication in water bodies and changes in the bio diversity. It degrades marble stone sculptures and architecture, corrodes metal structures and fades paint. Most buildings and structures are affected by this scourge to some degree and have helped to reduce the quality of housing and structures in our urban areas. To mitigate the

effect of acid rain on housing, building materials that are able to withstand the corroding effect of acid deposition be used in the construction of houses as well as regular maintenance of our buildings as a way of enhancing their quality and aesthetic value. This to a great extent will abate the impact of acid rain on our buildings as atmospheric pollution is continuous as long as man survives on the earth.

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