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Studies on the chemical properties of rainwater around the Distrito Industrial I, in the city of Manaus, Amazonas

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Abstract*— *The objective of this study is to verify if the Industrial Pole of Manaus has a significant participation in the polluting load of the region, through the identification of heavy metals present in the rainwater. Collectors were distributed at three strategic locations and three rainwater measurements were made and sent and sent to a specialized laboratory for analysis procedures. The method for analysis was Standard Methods for the Examination of Water and Wastewater, USA 2017. The results did not reveal significant concentrations of heavy metals, by the method adopted, but they revealed changes for chlorine, pH and electrical conductivity. Although there are no results for heavy metals other than iron, the other results show significant signs of industrial pollution.

Keywords*— *Toxic metals, Industrial pollution, Environment, Human health.

INTRODUCTION

Human activities, in particular industrial and transport activities, cause numerous pollutants to be released into the atmosphere that are harmful to the environment and humans, causing many problems that are often not observed or analyzed correctly.

Distrito Industrial, in Manaus, houses several industries from different segments, processing different raw materials, as well as some incinerators [34]. Knowing the products and by-products that are being dumped into the atmosphere is very important to characterize the tendency of the polluting load of some companies established in this micro region.

One of several studies conducted in this bias characterizes the chemical properties of rainwater, which have been developed in various areas of Manaus - AM, highlighting the study by Fernandes (2013) conducted by the Federal University of Amazonas - Ufam, which has shown promise, since it determines the quality and quantity of the polluting load of the Manaus Industrial Pole, AM.

The interference of man in the composition of the planet's atmosphere demonstrates the lack of knowledge of its consequences or the disregard of those known. The history of human life on earth is very recent and begins to significantly interfere in the atmosphere with the Industrial Revolutions and, if we consider the history begun when life began on Earth, such interference means nothing on this time scale. What remains for us is to predict the future to ensure the survival of the human species and to better understand the resources present in our Planet [8], [18].

Climate change as part of these anthropic actions are strongly affected by changes in the terrestrial radiation balance components, the understanding of these environmental phenomena involves the knowledge of chemistry, physics and mathematics, which make up the scientific-technological basis. Therefore, the notion of climate cycles should include other conditions, such as: solar phases, glacial ages, comet and asteroid fall, oceanic-atmospheric conditions and cycles related to tectonism, volcanism, cosmic rays and supercontinent formation [10], [20], [25].

What drives such anthropic interference is the pursuit of economic development and the improvement of society's living standards leading to the increasing consumption of natural resources. Chemicals play important roles in industries, transportation, among others, contributing significantly to the improvement of living standards. Its use causes the release of gases, toxic metals, volatile and soluble organic compounds, suspended solids, dyes, nitrogenous compounds, phosphorus in air, water and soil [18], [20], [28].

Another scientific research highlights the concentrations of CO2 in the atmosphere as the main climate regulator [10], according to Gerhardt; Reisdorfer; Cardoso (2017), in his analysis of pollutants in precipitation by industrial influences, highlights the concentrations of nitrogen and phosphorus, which are responsible for several problems, including the

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eutrophication of rivers and lakes, as well as human health problems. .

It is evident that the global climate is the result of the complex interaction between the energy radiated by the Sun and physical variables such as liquid masses, relief, vegetation, among other factors, explaining the multiplicity of climatic typologies. Thus, any change in this system results in a natural and dynamic adjustment, characterized as climate change, which are events that have always been part of the earth's evolution process [10], [25].

Every economic activity generates some kind of environmental impact, be it in the physical, biological or socioeconomic environment. The socioeconomic development brought an environmental pressure that from the point of view of the use of resources accelerated the process of change, taking as an example the use of natural resources such as minerals (sand, gravel, etc.), industrial elements (Pb, Zn, Cu , Au), fossil fuels (natural gas, oil, coal), biomass (waste, wood), generating pollutant emissions and other environmental problems [16].

Manaus Free Zone - ZFM, created in 1957, with numerous industries established prior to the enactment of Law No. 6,938, which instituted the National Environmental Policy - PNMA, in 1981 [3], [34]. Conama Resolution No. 357, which provides for guidelines on water bodies, of the year 2005, as well as Conama No. 491, which provides for air quality, of 2018 [6], [7], has its pollutant potential evidenced through of the industrial processes it uses.

These establishments, for the most part, are not included in the register of potentially polluting activities and users of natural resources of the Brazilian Institute of Environment and Renewable Natural Resources - IBAMA, and are not part of the list of the annual report of potentially polluting and users activities. environmental resources - RAPP [15], where all activities with potential pollutants are required to report annually their pollution potential and the processes adopted for mitigation.

The impacts of air pollution are: direct weather effects on radiation transfer, sunlight, visibility and development of fog and clouds, greenhouse gas production releasing CO2, CH4, NOx, chlorofluorocarbons and hydrogenated halocarbons, photochemical effects, ozone formation in the troposphere, acidification involving SO2, NOx and NH3, and societal disorders (dust, odor, smog) that affect health and quality of life [2].

In the same vein as Von Sperling (2009), he stated that water and air quality are interrelated and the impurities contained in water come from many sources, defining that for the environmental area the concept of water quality is much more complex when observed only its molecular formula H2O, having great solvent and particle transport capacity, incorporating several impurities, which define its quality.

Heavy metals have high levels of reactivity and bioaccumulation, triggering in the organism of living beings non-metabolizable chemical reactions, occurring their cumulativeness [27].

Notably, human activities in particular, industrial and transport, emit a load of pollutants and particles that harm the environment, such as acid rain that alters the hydrogenic potential (pH) of water bodies and harms the entire biota. Studies by Fernandes (2013), Neto (2015) and Kubota (2017) show that in addition to promoting human health problems, it can also compromise the artistic historical heritage. Identifying the chemical elements of these pollutants, such as inorganic metals, aims to know the air quality of a given region, thus seeking to reduce or even indicate treatment processes, aiming to minimize the impacts generated by them.

The objective of this study is to know the chemical properties of rainwater collected in an area around Distrito Industrial I, Manaus, Amazonas, identifying inorganic compounds such as cadmium, lead, chromium, iron, zinc and mercury; identify chlorine content, pH and electrical conductivity, comparing the results with the provisions of CONAMA Resolution No. 357/2005, which provides for the classification of water bodies and environmental guidelines for their framing, and the national standards of the air quality, established by CONAMA Resolution 491/2018, verifying if Manaus Industrial Pole has a significant participation in the polluting load of the region.

MATERIALS AND METHOD

2.1 Area of Study

The study area is located in the city of Manaus, Amazonas, located in the east and south, housing most of the industries. Samples were collected at three locations, where Image 1 indicates the sampling points.

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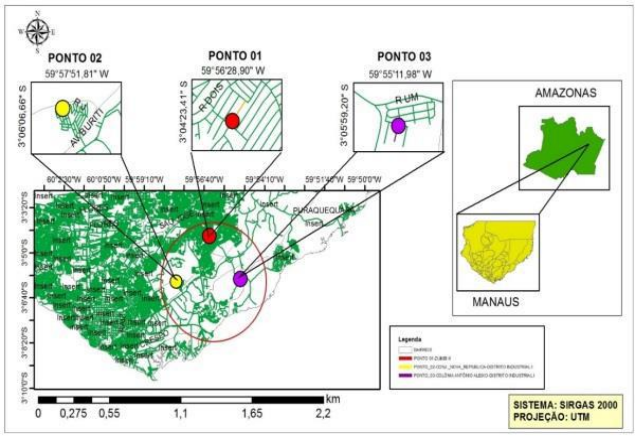

Image 1: Study area for rainwater survey. Source: Own authorship (2019)

2.2 Data Collection

Rainwater was collected through the locations named as: P-1, P-2 and P-3, beginning in June 2019 and ending in September 2019. For the collections, the following procedures were followed:

One liter of water was collected from previously sanitized GPP amber glass. The samples were analyzed in the laboratory of Micro-Lab Complexo de Diagnósticos Ltda, by the following procedures:

The laboratory used international models in accordance with the recommendations of the Standard Methods for the Examination of Water and Wastewater (23rd ed.); method 2510 B for conductivity analysis; Method 3030 E for the analysis of cadmium, iron, zinc, chrome and lead; method 3112 B for mercury analysis.

The electrical conductivity was analyzed using the digital conductivity meter. The samples were transferred to a nitric acid vial at pH <2.0, using the flame atomization and cold vapor atomization spectrophotometry equipment.

RESULTS AND DISCUSSION

Table 1 shows the results of the analysis of the samples collected from June to September 2019, including dry and rainy periods.

The method for the study did not reveal significant trace level concentrations for the metals Cd, Cr, Fe, Hg, Pb, Zn. The results obtained were different from those found by studies conducted by Fernandes (2013) and Santos E. (2019) at UFAM.

The results were influenced by weather conditions, due to the influence of the pollutant duration time in the place, as a function of the wind speed and direction, precipitation rate, temperature among other factors [33].

Some samples showed chloride indices, demonstrating that there are indications of industrial influences [14], associated with the incineration of plastic materials [30], characteristics of some factories installed in the Manaus Industrial Pole [34]. Concentrations are demonstrated in the analysis of variance in Image 2.

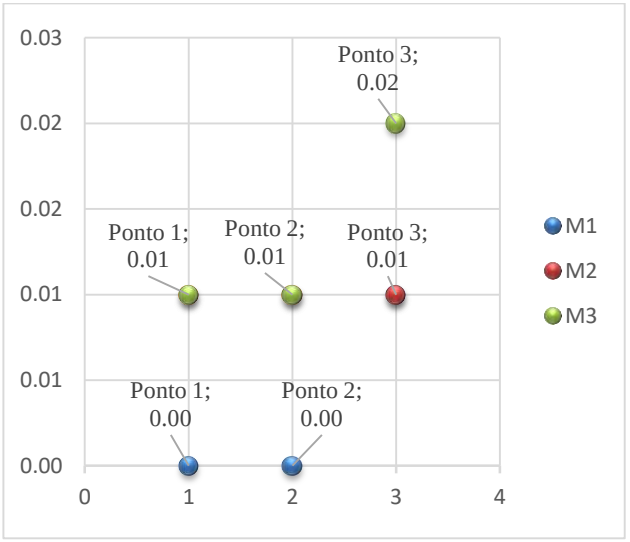

Image 2: Chlorine Variations.
Source: Own authorship (2019)

Analysis of variance shows that:

$F_{treatment}$= 2,42857; p > 0,05

F_{block}= 1,42857; p > 0,05

They do not present statistically significant differences [21].

The expected pH value for rainwater is 5.6, considered slightly acidic. The results of the samples show a pH with low acidification, neutral to alkaline, different from other results found as in the study by Botelho (2019), Fernandes (2013). For better understanding of the phenomenon more samples should be collected for studies of pH variations, the results of the analyzes are shown in Image 3.

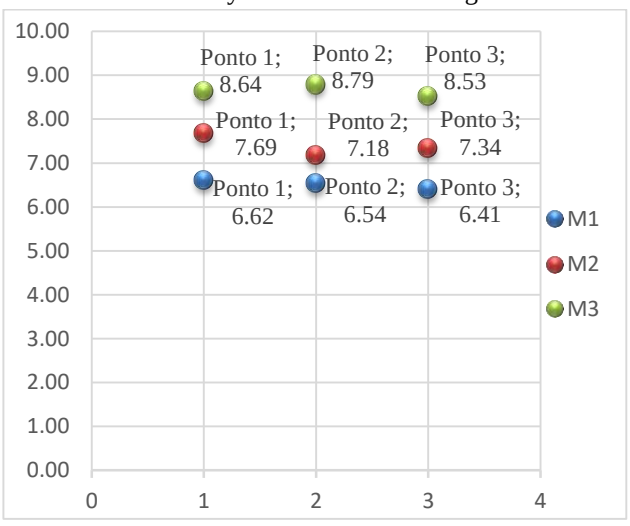

Image 3: pH variations. Source: Own authorship (2019)

Analysis of variance shows that:

$F_{treatment}$= 0,22835; p > 0,05

F_{block}= 0,002571; p > 0,05

They do not present statistically significant differences [21].

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Through the analysis of Image 4, it is noticed a high variation of the electrical conductivity for point two, this fact is indicative of a high content of ionic species such as sodium, potassium, calcium, magnesium among others, as well as suspended particulate materials carried in the atmosphere during precipitation [32].

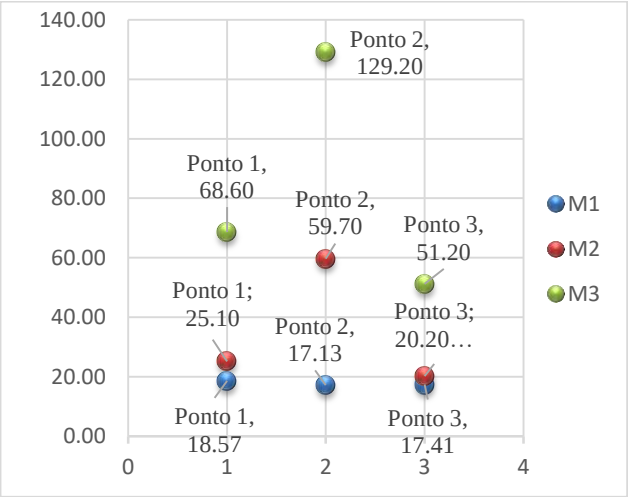

Image 4: Variations of electrical conductivity. Source: Own authorship (2019)

Analysis of variance shows that:

$F_{treatment}$= 1,3209; p > 0,05

F_{block}= 0,99; p > 0,05

They do not present statistically significant differences [21].

The presence of iron in sample three of point three can be explained by anthropogenic actions in industrial processes (paints, obtaining iron, fertilizers among others) suspended particulate material [1], [19]. After a dry period, the materials accumulated in suspension.

CONCLUSION

The method used to identify the concentrations of traces of heavy metals Cd, Cr, Fe, Hg, Pb and Zn did not reveal significant statistical results, which does not make the study unfeasible since more accurate analyzes can be employed to obtain positive results. Comparisons with current legislation are unfeasible. However, the results obtained with chlorine, pH and electrical conductivity show a polluting profile of Manaus Industrial Pole, evidenced by the positive result found in the chemical element iron, suggesting that several industries should be submitted to IBAMA potential polluters register.

The study demonstrated the behavior of pollutant transport via wet deposition and emphasizes the importance of monitoring heavy metals emitted by industrial processes, in view of the negative burden it exerts on the environment and man.

It is clear the necessity of greater investments in the scientific production of its relationship with the environment and human health in the city of Manaus, Amazonas.

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