https://dx.doi.org/10.22161/ijaers.710.38 ISSN: 2349-6495(P) | 2456-1908(O)

Air Pollution: Bibliometric Analysis and Space-Temporal Distribution of Specialized Scientific Production

Antônio Manoel da Silva Filho, Idelvan José da Silva, Kyonelly Queila Duarte Brito, Thiago Galvão Sobrinho, Lucia Helena Garófalo Chaves*

Department of Agricultural Engineering, Federal University of Campina Grande (DEAG/UFCG), Campina Grande, Brazil
*Corresponding Author

Abstract**—** *Environmental pollution, especially air pollution, is a serious problem that plagues the world population, due to the presence of solid and / or gaseous elements, which alter the characteristics of atmospheric air, causing diseases in humans. In this context, the objective of this work was to analyze the spatio-temporal distribution (1970 to 2020) of global scientific production regarding air pollution through a bibliometric analysis of data hosted on the Scopus and CAPES periodic platforms. To this end, a selection of the main publications about air pollution was carried out, in CAPES journals and Scopus, obtaining a profile of world production in the last 50 years (1970 to 2020), using bibliometric analysis. According to the data obtained, it was noticed that, of the 44 published articles, 31 were developed in Brazil, while 13 articles were developed in the rest of the world. It is also noted that, over the years, the number of published works increases, following the same trend of greater knowledge production in Brazil. Most of the published works were developed by authors affiliated with institutions in the Southeast, Northeast and South regions. In northeastern Brazil, only authors affiliated with Rio Grande do Norte, Pernambuco, Bahia and Ceara appear. These works were mainly indexed in the areas of medicine, environmental sciences and social sciences. Therefore, when analyzing scientific production, it was concluded that air pollution has a major negative impact on the health of the population, especially in large centers where there is a higher emission of pollutants, thus triggering respiratory diseases.*

Keywords**— *Pollutants, Atmospheric Air, Environment, Respiratory Diseases.***

I. INTRODUCTION

Air pollution, today, is a serious environmental problem, due to air contamination by certain solid and / or gaseous elements called pollutants, that is, an air pollutant is any gas or particulate material that, in high concentration can be harmful to life, the environment and / or property.

Pollutants originate from natural sources, anthropogenic or both. Natural sources of air pollution include smoke from forest fires, volcanic ash that is emitted in the troposphere and stratosphere, and winds bringing dust from cultivated agricultural fields. A study by [1] revealed that 96% of the total ammonia emitted in Europe is due to the management of organic waste and fertilizers from agricultural soils. Anthropogenic air pollution enters the atmosphere from fixed and mobile sources, while fixed sources include factories, power plants, ore smelters and farms, while mobile sources include all forms of transport that burn fossil fuel.

Air pollutants are classified into two categories, primary and secondary, the primary ones being carbon monoxide (CO), hydrocarbon (HCs), particulate materials (solid particles or liquid droplets), sulfur dioxide (SO_2), nitrogen oxides (NOx) and lead. Secondary pollutants are formed during chemical reactions between primary pollutants and other atmospheric constituents, such as water vapor (EPA-Environmental Protection Agency USA). Ozone (O_3) is considered a secondary pollutant because it is formed from the chemical reaction induced by the photochemical oxidation of volatile organic compounds (VOCs) and NO_2 in the presence of ultraviolet rays from sunlight [2]. In addition to these pollutants, EPA identified 188 chemicals that are considered to be dangerous or toxic air pollutants for urban air. Many of them are volatile organic chemicals,

https://dx.doi.org/10.22161/ijaers.710.38 ISSN: 2349-6495(P) | 2456-1908(O)

such as benzene found in gasoline and used as a solvent, and trichlorethylene, which is used as a solvent. Mercury is an example of a dangerous inorganic compound.

Air pollution has affected several segments of society, for example, it represents an ecological risk with negative consequences for biodiversity; it is capable of causing damage to building structures and corroding the external surfaces of buildings, especially those constructed with limestone materials that react with precipitated acid solutions [3];vegetation can be damaged by the absorption of pollutants through the leaf surface and / or by leaf damage in susceptible plants due to sufficiently high concentrations of sulfur dioxide or ozone. For example, annual losses of 4% have been recorded in the cultivation of corn, 10% in the cultivation of wheat and 11% in the cultivation of soybeans, due only to ozone [4]. Even with chronic exposure to relatively low levels of pollution, plants can be harmed by reducing their resistance to diseases and insect predators, reducing crop yields.

However, more commonly, air pollution poses a health risk that can damage life, harming the human respiratory and pulmonary systems. According to data from the Institute for Health Metrics and Evaluation [5], air pollution has already caused more than 80 million deaths worldwide since the beginning of the 21st century. The harmful effects of air pollution on the health of the population have increasingly drawn the attention of the scientific community, especially that associated with emissions in large urban centers[6].

Children, adolescents and the elderly are the age groups most susceptible to the effects of air pollutants and the cases related to respiratory problems (asthma, pneumonia and bronchitis) in children have increased significantly [7].

In addition, the negative effects of air contamination affect the population in an unequal way, with the middle and lower class regions being the most affected and, in addition to causing serious damage to health, it has also generated high costs to the State, since they bear with the consequences of air contamination such as an increase in the number of visits, deaths and hospital admissions, in addition to the high expenses with medications that could be avoided by improving air quality [8]. Studies, considering 29 Brazilian capitals, estimated monetary losses in the order of US $ 1.7 billion annually related to air pollution [9].

One of the main obstacles is that most Brazilian states do not have monitoring of air quality, so it is necessary to implement public policies that seek to adopt measures to minimize, prevent and / or remedy the effects of air pollution. in the health of the population, especially the elderly and children. However, the lack of monitoring and data on air quality in states and cities, except in large industrial centers that already have air quality monitoring, as is the case in the city of São Paulo, makes it even more difficult to implement these measures. It should be noted that the lack of data limits scientific production, and further research is needed to highlight the current air quality scenario and the impacts that are being caused.

In this context, the objective of this work was to analyze the spatio-temporal distribution (1970 to 2020) of global scientific production regarding air pollution through a bibliometric analysis of data hosted on the Scopus and CAPES periodic platforms.

II. MATERIALS and METHODS

1.1. Search classifiction

The research comprised an exploratory-descriptive study, mainly because it describes the study context and allows greater familiarization of the academic community with the peculiarities related to the theme [10].

Bibliometrics is a methodology from information sciences that uses mathematical and statistical methods to map documents from bibliographic records stored in databases. This technique also allows relevant findings such as: number of production by region; temporality of publications; organization of research by area of knowledge; count of literature related to the study citation; identification of the impact factor of a scientific publication among others that contribute to the systematization of the research result and the minimization of the occurrence of bias when analyzing a given theme [11].

2.2. Data collection and analysis

As a literature search method, systematic search was used in the online databases of Scopus and CAPES journals, followed by a bibliometric analysis of the results. Bibliometric analysis was performed according to the methodology described by [11], with adaptations.

The research planning was carried out in May and June 2020. In this stage, the search terms were defined as the combination “Air pollution AND Northeast”, “Pollution AND air AND Northeast”, “air pollution AND Northeast” and “pollution AND air AND Northeast”, avoiding that divergent themes from this were rescued by the search. The combination of terms was inserted in the search on July 10, 2020, without time, language or any other restriction that could limit the result. After obtaining a certain number of published work records, filtering by country was applied, limiting the results to Brazil, where

https://dx.doi.org/10.22161/ijaers.710.38 ISSN: 2349-6495(P) | 2456-1908(O)

only works developed in the Northeast region of Brazil were subsequently selected.

The number of documents published worldwide was expressed by countries, then data from the Northeast region of Brazil were expressed by year of publication, area of concentration, periodicals, states in the Northeast region, educational and / or research institutions and authors. The data obtained were submitted to descriptive analysis [12] using an electronic spreadsheet.

III. RESULTS ANDDISCUSSION

With the obtained data, there was a greater production of free access articles (35) and 9 (25.7%) restricted access articles (Figure 1). Similar behavior was observed with the production data in Brazil, where the number of documents with free access (27) was 6.75 times greater than that found in restricted access scientific literature (4). Worldwide, publications with this theme are reduced, with a total of 13 publications divided into 8 open access and 5 private access.

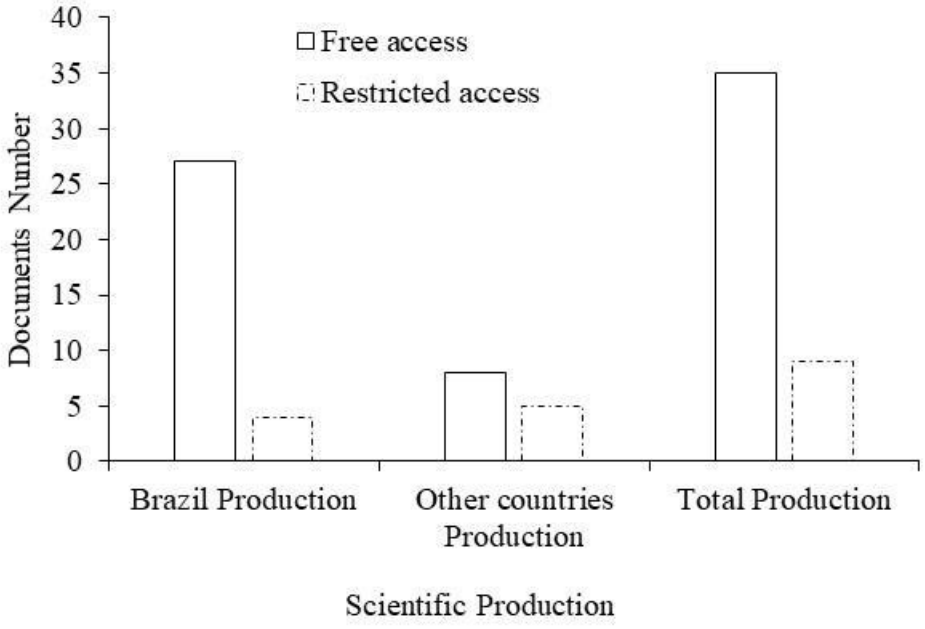

Fig. 1: Documents number depending on the type of access.

Brazil stood out with a greater number of published documents, with 31 publications (Figure 2). This may be a reflection of an accelerated urbanization process in the country that has caused a decrease in air quality, promoting the interest of researchers in studying the consequences of this pollution in the country. The main pollutants monitored in Brazil and in the world are nitrogen oxides (NO_2 or NO_x), volatile organic compounds (VOCs), carbon monoxide (CO) and sulfur dioxide (SO_2) [2]. Another factor that possibly contributed to a higher publication rate in Brazil is the fires that the country has suffered in recent years [13] [14].

https://dx.doi.org/10.22161/ijaers.710.38 *ISSN: 2349-6495(P) | 2456-1908(O)*

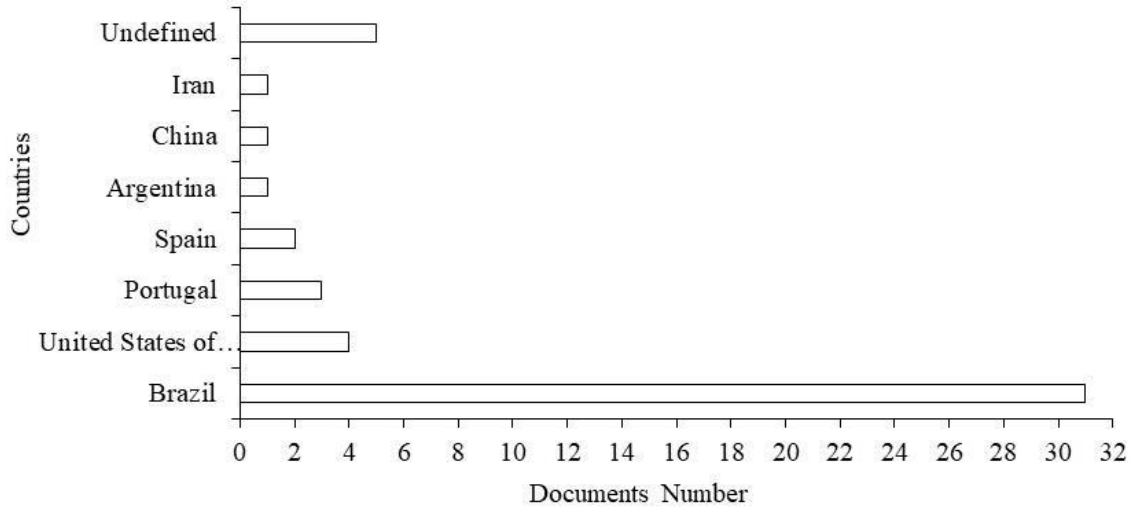

Fig. 2: Documents number published according to each country studied.

The distribution of the number of publications in the last 50 years, referring to the period between the 1970s and 2020 is shown in Figure 3. The data collected showed an increase in the number of publications only from the year 2008. The years of greatest publication were 2010, with 9.1%; 2016, with 9.1%, and 2018, with 11.4% of total production. This information demonstrated that the subject is contemporary, being a problem studied worldwide, showing a greater concern with human health. The increase in the number of documents from 2010 in Brazil, may be related to the communication by the monitoring agencies about the increase in the number of fires in the North and Midwest region of the country, which promoted a greater emission of particulate materials in the air, promoting damage to human health [15].

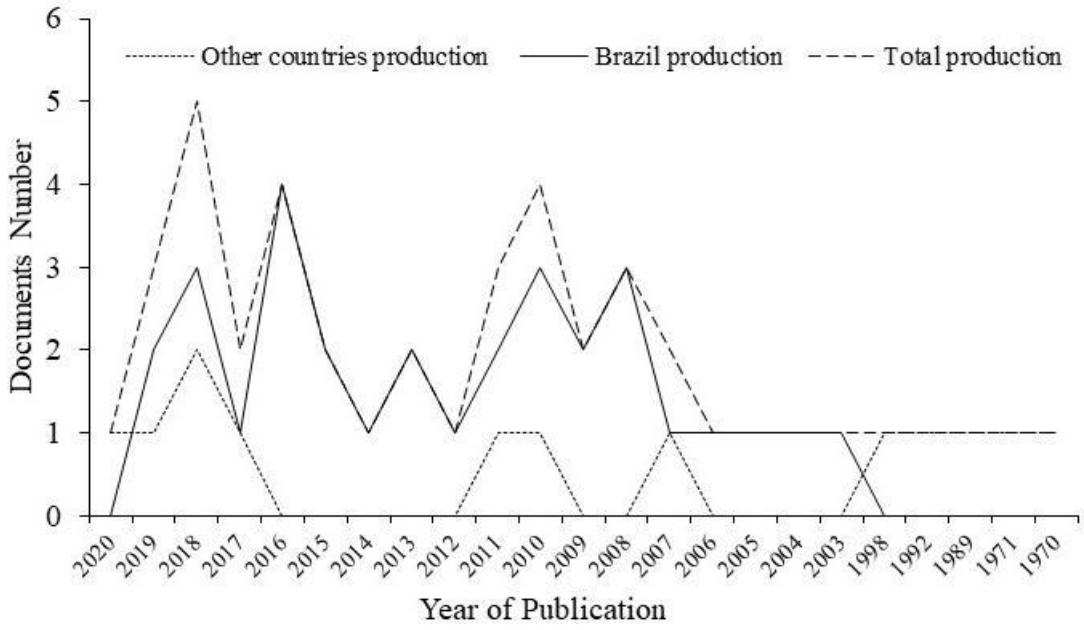

Fig. 3: Documents number published for the period from 1970 to 2020.

Brazil had a higher average of scientific production, when compared to the world average (other countries) (Figure 4). Total production in Brazil was greater than the average world (other countries) production in the years 2008, 2009, 2010, 2011, 2013, 2015, 2016 and 2018, while in the years 1970 to 2007, 2012, 2014 and 2017 the Brazilian production was lower than the world average (other countries). This can be justified by the fact that Brazil is a developing country with the increase of facilities of multinational industries and an increase in the population,

https://dx.doi.org/10.22161/ijaers.710.38 *ISSN: 2349-6495(P) | 2456-1908(O)*

which has caused more and more pollution of the atmospheric air. Another factor that may have contributed to the increase in the number of publications may be related to international treaties, which, in turn, seek to solve environmental problems, especially regarding air pollution.

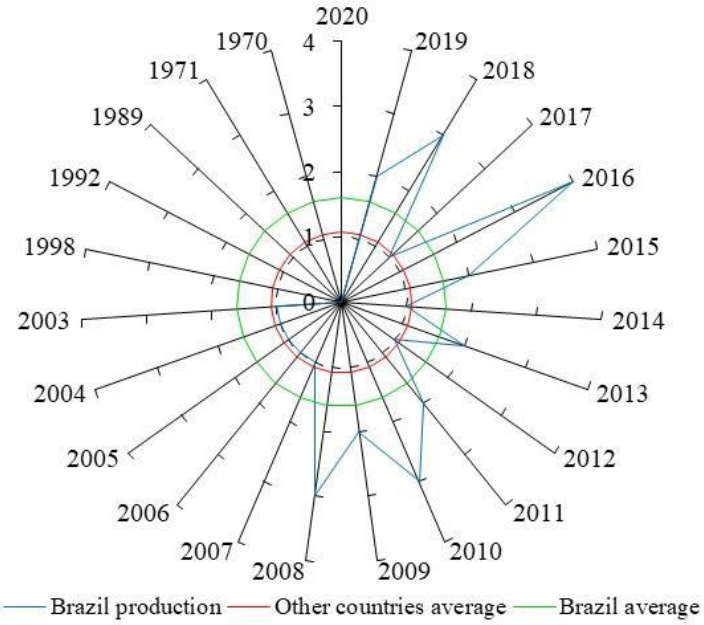

Fig. 4: Scientific production in Brazil, world average and in Brazil over the last 50 years.

The largest scientific production since 1970 until today, was in the area of medicine, both world production (other countries) and Brazilian production (Figure 5). Scientific production in the field of medicine in Brazil was much higher than scientific production worldwide, and in Brazil nineteen articles were produced, while in the rest of the world only six articles were produced (Figure 5).

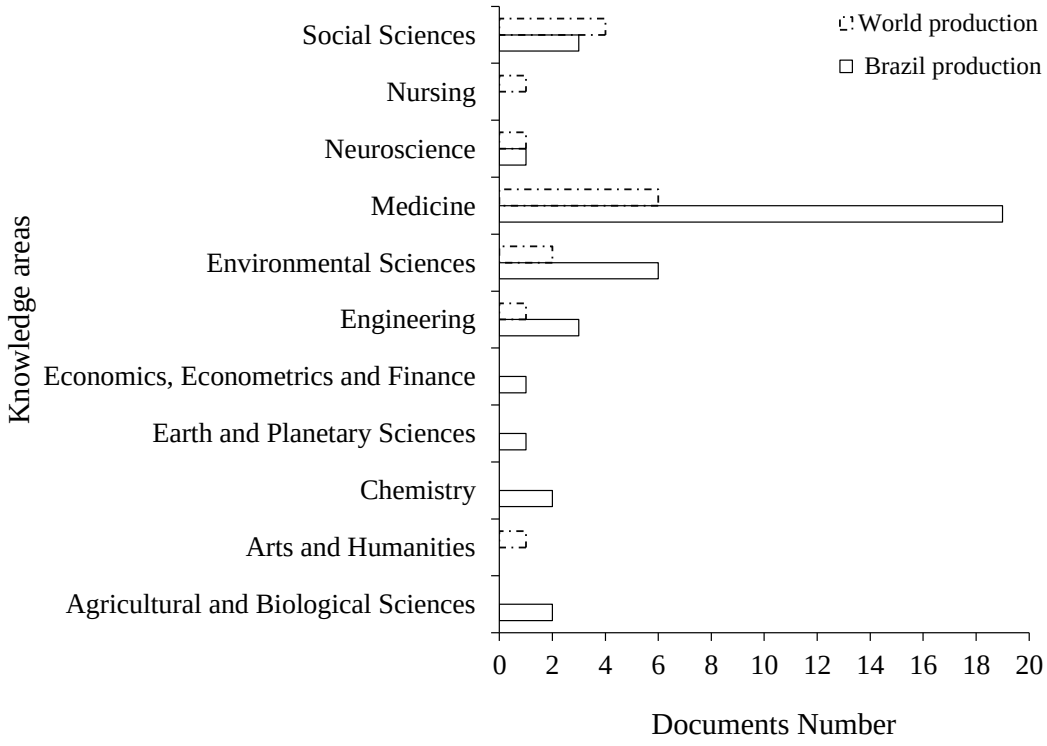

Fig. 5: Documents number published (1970-2020) by area of knowledge.

https://dx.doi.org/10.22161/ijaers.710.38 *ISSN: 2349-6495(P) | 2456-1908(O)*

The second largest production was in the area of environmental sciences, where Brazilian production was greater than world scientific production, producing six and two articles, respectively. It was also found that the third largest scientific production was in the area of social sciences (Figure 5). In this area, unlike the others mentioned above, the largest production recorded was world production (4 articles) and the lowest was Brazilian production (3 articles).

According to the data presented above, as expected, articles published in the fields of medicine, environmental sciences and social sciences were also published in scientific journals directly related to the area of study (Figure 6). Of the 44 articles published, 31 of them were published in Brazilian journals, while 13 were published in journals from other countries. In descending order of production, the journals that most published articles were: Cadernos de Saúde Pública (6), Ciência e Saúde Coletiva (5), Holos (3), Revista de Saúde Pública (3), Arquivos de Neuropsiquiatria (2), Cadernos de Saúde Pública do Ministério da Saúde Fundação Oswaldo Cruz (2) and SAE Technical Papers (2),as shown in Figure 6.

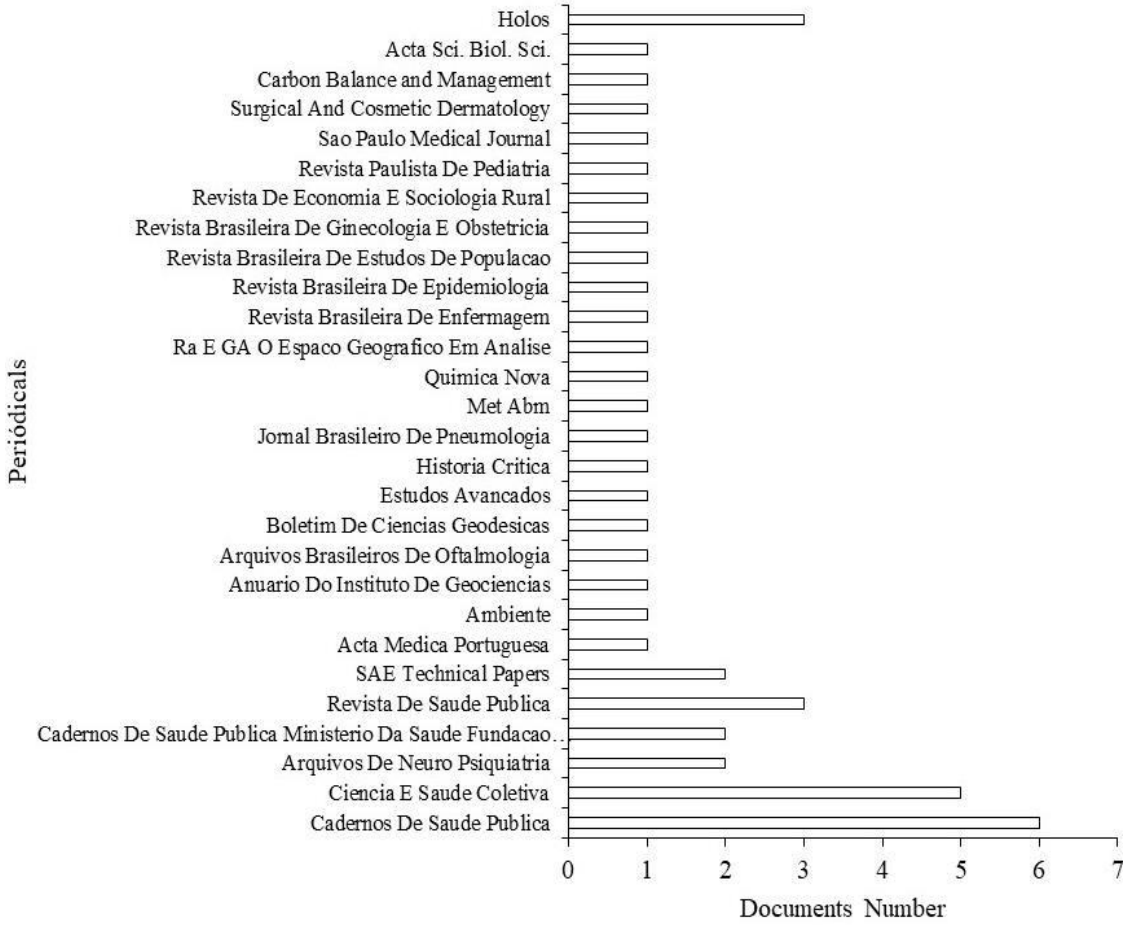

Fig. 6: Documents number published in national and international journals during the period from 1970 to 2020.

The data presented in Figures 5 and 6 demonstrated the concern of researchers regarding the deleterious effects that air pollution can cause on the environment, on the human body and on society in general. Scientific productions in the areas of medicine, environmental and social sciences in specialized journals in public health, show great concern of scientists with the health and well being of the population, reinforcing the interest in this theme, in view of the increase in the number of studies in the last years (Figure 3).

In this conjecture, the growth of publications in Brazil stems from an intense search for the reduction of the environmental impacts caused by air pollution, since the earth cries out for it and, thus, with the advance of science, the number of publications and consequently, international treaties were carried out to minimize the impacts of pollution, the main ones being: Tbilisi Conference

https://dx.doi.org/10.22161/ijaers.710.38 *ISSN: 2349-6495(P) | 2456-1908(O)*

(Georgia, 1977); ECO-92 (1992, Rio de Janeiro, Brazil); Kyoto Protocol (1997, Kyoto, Japan); Agenda 21 (Rio de Janeiro, Brazil, 1992; Johannesburg, South Africa, 2002); Rio + 10 (Johannesburg, South Africa, 2002) and Rio + 20 (Rio de Janeiro, Brazil, 2012).

At the Tbilisi Conference, several recommendations and criteria were established that should be observed for a better use of nature, in order to satisfy human needs without compromising nature [16].At ECO-92, the need to preserve forest resources on the planet and conservation of biological diversity was discussed, aiming at reducing the exacerbated consumption of raw materials for industries [17].Discussions at the event called the Kyoto Protocol, it was agreed that more industrialized countries should join efforts to reduce the emission of polluting gases, such as carbon dioxide [18].Agenda 21 brought up the importance of sustainable development, concerned with the preservation of the atmosphere and oceans, Indians, riverside dwellers, the insertion of women and young people in the social context [19].Rio + 10, again discussed what had been proposed in ECO-92 and Agenda 21, that is, about the objectives achieved and new strategies for mitigating environmental impacts [20].Rio + 20, on the other hand, was about the importance of renewing the political commitment to sustainable development from the Tbilisi Conference to the Rio + 10 treaties. In addition to the themes of the previous treaties, new themes are added to this conference, such as, the green economy in the context of sustainable development and the eradication of poverty and the institutional structure for sustainable development [21].

In view of the above, it is noted that the global concern about the environment arose from ecological ideas that were widely disseminated since the 1970s, with the Tbilisi Conference as its starting point. From then on, several study groups around the world were not restricted only to environmental and human health issues, but also to social and cultural aspects (Figures 5 and 6).

With regard to scientific production in Brazil, authors from various regions of Brazil figure with important contributions to the advancement of the state of the art on air pollution (Figure 7). In descending order, the authors who presented the largest number of publications were: Junger, W.L and Leon, A.P, appearing in 5 articles; Braga, A.L.F, Gouveia, N., Martins, L.C. and Pereira, L.A.A. appear in 3 articles. It should be added that these authors stand out from the others for presenting a scientific production above the average worldwide and Brazilian production.

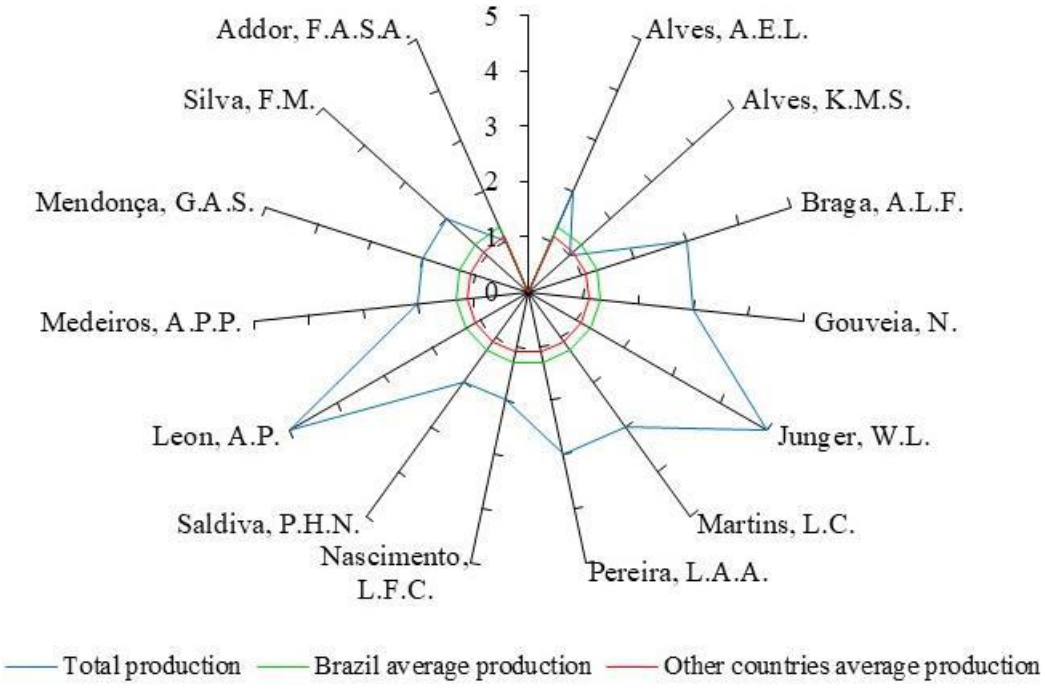

Fig. 7: Total scientific production by authors and average world and Brazilian production between 1970 and 2020.

https://dx.doi.org/10.22161/ijaers.710.38 ISSN: 2349-6495(P) | 2456-1908(O)

The studies by [22], focus on assessing air quality and acute respiratory disorders in children [23], air pollution and health impacts in the Metropolitan Region of Belo Horizonte, Minas Gerais, Brazil [24], air pollution and hospitalizations for diseases in the subequatorial Amazon: a time series approach [25] and air pollution and respiratory and cardiovascular diseases: a time series study in Cubatão, State of São Paulo, Brazil [26] and [22].

The studies by Braga, A.L.F., correlated air pollution and low birth weight in an industrialized city in southeastern Brazil, in the years 2003 to 2006 [27], air pollution and the health of children: a sickle cell disease [12] and air pollution and respiratory system [2].

The studies by Gouveia, N., were focused on air pollution and health impacts in the Metropolitan Region of Belo Horizonte, Minas Gerais, Brazil [24], perinatal mortality and air pollution generated by vehicles [28] and the relationship between low birth weight and air pollution in the city of São Paulo [29].

The authors Martins, L.C. and Pereira, L.A.A. are part of the research group composed by the authors [2], [12] and [27], which appear in the same publications previously mentioned.

Given the above, it was noticed that studies demonstrate that there are serious environmental problems that contribute to air pollution in the studied places, such as the presence of particulate matter (PM10; PM2.5), sulfur dioxide (SO_2) and ozone (O_3), carbon monoxides (CO) and nitrogen dioxide (NO_2). It should be noted that the studies have a bias towards the medical and health sciences (Figures 5 and 6). In this sense, it is necessary that government policies are adopted to mitigate air pollution and, with this, reduce the harmful effects of pollution on the environment, on society and, above all, on human health.

Considering the number of authors who had their articles published, it was noticed that the authors have affiliations in different institutions and regions of Brazil (Figure 8).

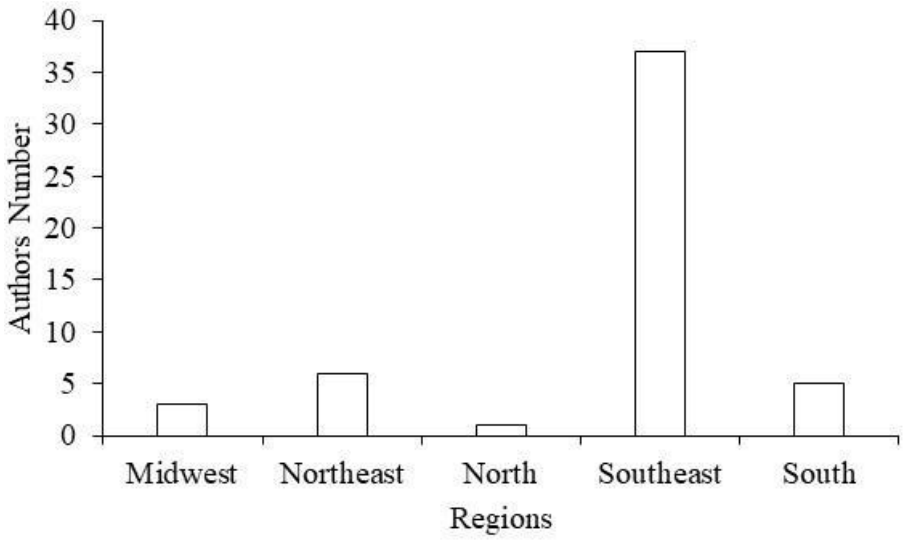

Fig. 8: Authors number belonging to institutions in different Brazilian regions.

Also analyzing Figure 8, it was found that most of them are affiliated with institutions in the Southeast region with 35 authors, followed by the Northeast with 6 authors, South with 5 authors, Midwest with 3 authors and the North region with only 1 author.

This fact may be related to the development of the regions, in which in the Southeast Region of Brazil there is a high level of development and the largest urban centers of the country are present, as a consequence a greater number of factories and industries, a large fleet of vehicles , and a greater concentration of people; on the other hand, the North Region has few industries in comparison to the other regions of Brazil and small demographic density, and these facts may be directly related to the number of authors, research and publications by region.

In Brazil, the largest urban centers such as São Paulo and Rio de Janeiro, have high rates of industrial and vehicular air pollution. For this reason, the first records in Brazil of the manifestation of diseases related to air pollution occurred in these cities. From these episodes, verified in the main urban centers of Brazil, that the theme of air pollution aroused the interest in the academic community

https://dx.doi.org/10.22161/ijaers.710.38 ISSN: 2349-6495(P) | 2456-1908(O)

of several Brazilian cities, through studies to investigate the evidence of air pollution and its effects on human health [30].

Analyzing the number of articles published with affiliations in the states of the Northeast region **(**Figure 9) as an object of study, the states of Rio Grande do Norte and Pernambuco have 02 authors each, Ceará and Bahia with only one author; in the other states of the Northeast Region, authors and publications related to air pollution were not found. This fact can also be related to the size of cities and their development; the states of the Northeast that had publications are states with a greater number of industries, a large number of vehicles and a large part of the population resides in these urban centers, decreasing the quality of the air as in the Metropolitan Region of Recife.

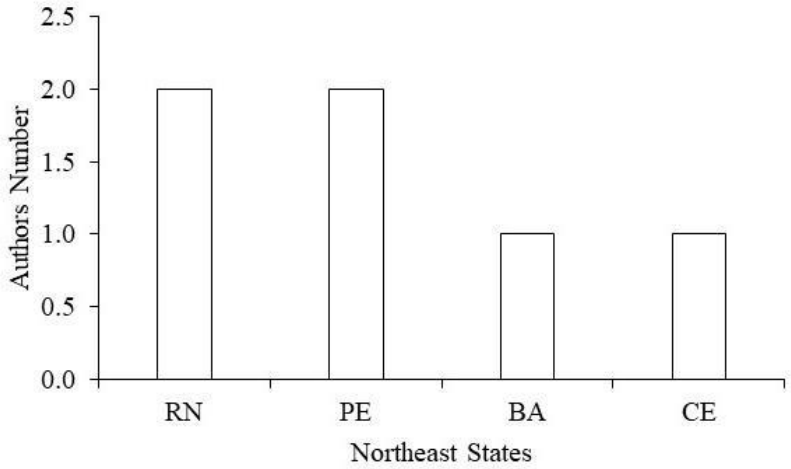

Fig. 9:Authors number affiliated with institutions belonging to Rio Grande do Norte (RN), Pernambuco (PE), Bahia (BA) and Ceará (CE) States, northeast region of Brazil.

From the general analysis of the publications, it was found that the topic of air pollution was more addressed with the concern of people's health than of the Environment itself. It is true that air pollution affects people's health, especially in children and the elderly, with respiratory and lung diseases being more frequent, but they can also, in a more critical state, develop cardiovascular diseases and the appearance of some types of cancer. The most frequently studied events related to air quality and health are morbidity and mortality from respiratory and cardiovascular diseases, lung cancer, decreased respiratory function and school absenteeism [22].

The increasing number of vehicle circulation in the world and industrial activities are factors that contribute strongly to the pollution of the atmosphere [31]. This can also be caused by natural sources such as accidental burning of biomass (material derived from plants or animals) and volcanic eruptions [32]. The records of the publications became more evident in regions of large urban centers, relating air quality to the impact of human activities, with the presence of large industries and great movement of vehicles.

The publications found that highlighted the negative environment were few found, and it is observed that the existing ones are related to the increase in the greenhouse effect and the increase in the frequency of acid rains.

IV. CONCLUSIONS

Air quality in the atmosphere is an extremely important issue for human life and the environment. With the increase in industrial activity, demographic growth and the construction of large urban centers have had negative impacts on human health.

The research showed quantitative results related to air pollution studies, finding that poor air quality results in negative impacts for children and the elderly, with the most frequent respiratory diseases.

The general analysis of the publications made it possible to establish a standard in terms of space, in which the largest number of publications was related to large urban centers, thus allowing the association of the functioning of industries, a large route of vehicles and population growth to the decrease in air quality and consequently increase in respiratory diseases.

As for time, it was clear that, with the advancement of international discussions and treaties on the preservation of the environment, the interest of researchers increased and, with this, a greater number of publications were made.

https://dx.doi.org/10.22161/ijaers.710.38 *ISSN: 2349-6495(P) | 2456-1908(O)*

CONFLICTS OF INTEREST

The authors declare no conflicts of interest regarding the publication of this paper.

REFERENCES

[1] Backes, A.M., Armin, A., Bieser, J., Matthias, V., Quante, M. (2016) Ammonia Emissions in Europe, Part II: How Ammonia Emission Abatement Strategies Affect Secondary Aerosols. Atmospheric Environment, 126, 153-161.

[2] Arbex, M.A., Santos, U.P., Martins, L.C., Saldiva, P.H.N., Pereira, L.A.A., Braga, A.L.F. (2012) A poluição do ar e o sistema respiratório. Jornal Brasileiro de Pneumologia, 38, 643-655.

[3] Alberini, A., Bigano, A., Post, J. and Lanzi, E. (2016) Air pollution and human health: approaches and issues when valuing the costs of inaction. OECD Environment Working Papers, 108, 1-49.

[4] UNECE, Comissão Económica Das Nações Unidas Para A Europa. (2018) Air Pollution and Evironmental Policy,.Disponível em https://www.unece.org/env/lrtap/welcome.html.html. Acesso em 10 agosto de 2020.

[5] IHME. Institute For Health Metrics And Evaluation. (2017) State of Global Air: A special report on global exposure to air pollution and its disease burden. 16p.

[6] Habermann, M., Medeiros, A.P.P., Gouveia, N. (2011) Tráfego veicular como método de avaliação da exposição à poluição atmosférica nas grandes metrópoles. Revista Brasileira de Epidemiologia, 14, 120-130.

[7] Leandro, D.S., Angeoletto F. (2017) Poluição atmosférica em cidades médias: uma proposta de avaliação para Rondonópolis-MT. Revista Espaço Acadêmica, 17, 1-9.

[8] Prato, M.I.C., Silveira, A.,Neves, E.T., Buboltz, F.L. (2014) Doenças Respiratórias na Infância: Uma Revisão Integrativa. Revista da Sociedade Brasileira de Enfermeiros Pediatras, 14, 33-39.

[9] Miraglia, S.G., Gouveia, N. (2014) Costs of air pollution in Brazilian metropolitan regions. Ciência e Saúde Coletiva, 19, 4.141-4.147.

[10] Marconi, M.A., Lakatos, E.M. (2011) Metodologia científica. 6nd. Edition, Atlas, São Paulo.

[11] Machado, A.B., Silva, A.R.L., Catapan, A.H. (2016) Bibliometria sobre concepção de habitats de inovação. Navus-Revista de Gestão e Tecnologia, 6, 88-96.

[12] Barbosa, J.C., Maldonado Júnior, W. (2015) Experimentação Agronômica e AgroEstat - Sistema para Análises Estatísticas de Ensaios Agronômicos. Funep, Jaboticabal.

[13] Pereira, J.A.V., Silva, J.B. (2016) Detecção de Focos de Calor no Estado da Paraíba: um estudo sobre as queimadas. Revista Geográfica Acadêmica, 10, 5-16.

[14] Silva Junior, C.H.L., Anderson, L.O., Oliveira, L.E., Aragão, C., Rodrigues, B.D. (2018) Dinâmica das queimadas no Cerrado do Estado do Maranhão, Nordeste do Brasil. Revista do Departamento de Geografia, 35, 1-14.

[15] Fernandes, T., Hacon, S. S., Novais, J.W.Z., Sguarezi, S.B., Silva, C.J., Alcântra, L. C.S., Curvo, A.D., Fernandes, T. (2019) Poluição do ar e efeitos na saúde de crianças na Amazônia paraense: uma análise bibliométrica. Research, Society and Development, 8, e4984907.

[16] Cavalcante, N.S.P. (2020) Um olhar sobre a trajetória da educação ambiental. Revista EDUCAmazônia, 25, 233-249.

[17] Lira, J. R. (2014) Águas da Pan-amazônia: a gestão de recursos hídricos em tempos de escassez (1970-2012). Dissertação (Dissertação em sociedade e fronteiras) – UFRR. Boa Vista, p.30.

[18]Bueno, M.P., Calcagno, D. (2020) La diplomacia brasileña y la gobernanza del cambio climático. Las propuestas de Brasil en Kyoto y en París (1997 y 2015). Astrolabio, 25, 274-297.

[19] Vital, T.T., Quaglia, M.L.A. (2020) Gestão do tratado de cooperação amazônica/organização do tratado de cooperação amazônica sobre as bacias hidrográficas amazônicas. Cadernos eletrônicos, 2, 1-20.

[20] Oliveira, M.V.G., Camelo, G.L. (2019) Indicadores ambientais para o Instituto Federal de Educação, Ciência e Tecnologia do Rio Grande do Norte. Holos, 8, 1-13.

[21] Santos, D.M.C. and Medeiros, T.A. (2020) Desenvolvimento sustentável e agenda 21 brasileira. Ciência Atual, 15, 10-27.

[22] Junger, W.L., De Leon, A,P. (2007) Air pollution and low birth weight in the city of Rio de Janeiro, Brazil. Cadernos de Saúde Pública, 23, S588-S598.

[23] Moura, M., Junger, W.L., Silva, G.A., De Leon, A.P. (2008) Air quality and acute respiratory disorders in children. Revista de Saúde Pública, 42, 1-8.

[24] Gouveia, N., De Leon, A.P., Junger, W.L., Lins, J.F., Freitas, C.U. (2017) Poluição do ar e impactos na saúde na Região Metropolitana de Belo Horizonte – Minas Gerais, Brasil. Ciência e Saúde Coletiva, 24, 3773-3778.

[25] Ignotti, E., Hacon, S.S., Junger, W.L., Mourão, D., Longo, K., Freitas, S., Artaxo, P., Leon, A.P. (2010) Air pollution and hospital admissions for respiratory diseases in the subequatorial amazon: A time series approach. Cadernos de Saúde Pública, 26,747-761.

[26] Nardocci, A.C., Freitas, C.U., De Leon, A.P., Junger, W.L., Gouveia, N.C. (2013) Air pollution and respiratory and cardiovascular diseases: A time series study in Cubatão, São Paulo State, Brazil. Cadernos de Saúde Publica, 29, 1867-1876.

[27] Reis, M.M., Guimarães, M.T., Braga, A.L.F., Martins, L.C., Pereira, L.A.A. (2017) Air pollution and low birth weight in an industrialized city in Southeastern Brazil, 2003-2006. Revista Brasileira de Epidemiologia, 20, 189-199.

[28] Novaes, H.M.D., Gouveia, N.,Medeiros, A.P.P. (2010) Perinatal mortality and traffic-related air pollution. Revista Brasileira de Ginecologia e Obstetrícia, 32, 471-474.

https://dx.doi.org/10.22161/ijaers.710.38 *ISSN: 2349-6495(P) | 2456-1908(O)*

[29] Medeiros, A.P.P., Gouveira, N. (2005) Relationship between low birthweight and air pollution in the city of Sao Paulo, Brazil. Revista de Saúde Publica, 39, 965-972.

[30] Alves, K. M. S., Alves, E. L. A., Silva, M. S. (2009) Poluição do Ar e Saúde nos Principais Centros Comerciais da Cidade de Natal/RN. Holos, 4, 81-95.

[31] Cesar, G.C.A., Nascimento, C.F.L., Carvalho, A.J. (2013) Associação entre exposição ao material particulado e internações por doenças respiratórias em crianças. Revista de Saúde Pública, 47, 1209-1212.

[32] Cançado, J.E.D., Braga, A., Pereira, L.A.A., Arbex, M.A., Saldiva, P.H.N., Santos, U.P. (2016) Repercussões clínicas da exposição à poluição atmosférica. Jornal Brasileiro de Pneumologia, 32, S5-S11.