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Social isolation and air quality impacts: the Rio de Janeiro case study

Isolamento social e impactos na qualidade do ar: o caso do Estado do Rio de Janeiro

Aislamiento social y sus efectos en la calidad del aire: un estudio de caso en el Estado de Rio de Janeiro

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Abstract

Many debates about environmental issues surfaced with the advent of the new coronavirus and social distancing. Therefore, the present article aimed to investigate air quality impacts in Rio de Janeiro, during social isolation period. In order to confirm air pollutants, decrease, for example NO and particulate material, documents such as legislations, technical standards, scientific articles published in this period, were analyzed during the studied period. Furthermore, the article sought to bring awareness about the short temporality of the air quality improvement, since without more sustainable forms of production, in a little while, those pollutants may increase again.

Keywords: Coronavirus; Social isolation; Air quality; Atmospheric pollution and environment.

Resumo

Muitos debates sobre as questões ambientais vieram à tona com o advento do novo coronavírus e do distanciamento social. Dessa maneira, o presente estudo teve como objetivo investigar os impactos causados na qualidade do ar no estado do Rio de Janeiro, durante o período de isolamento social. Para isso, foram analisados documentos, como legislações, normas técnicas e artigos científicos publicados nesse período, no qual auxiliaram na comprovação da redução de poluentes como o NO e o material particulado durante o período estudado. Ademais, buscou trazer reflexões sobre a curta temporalidade dessa melhoria da qualidade do ar, visto que sem formas de produção mais sustentáveis, em um curto espaço de tempo, os poluentes podem voltar a aumentar.

Palavras-chave: Coronavírus; Isolamento social; Qualidade do ar; Poluição atmosférica e Meio ambiente.

Resumen

Con la llegada del nuevo coronavirus y el distanciamiento social han surgido muchos debates sobre cuestiones ambientales. Por lo tanto, este estudio tenía como objetivo investigar los impactos causados en la calidad del aire en el estado de Río de Janeiro durante el períodо de aislamiento social. Para ello se analizaron documentos como la legislación, normas técnicas y artículos científicos publicados durante este período, que ayudaron a demostrar la reducción de contaminantes como el NO y las partículas durante el período estudiado. Además, trató de aportar reflexiones sobre la corta temporalidad de esta mejora de la calidad del aire, ya que sin

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formas de producción más sustentables, en un corto período de tiempo, los contaminantes pueden volver a aumentar.

Palabras clave: Coronavirus; Aislamiento social; Calidad del aire; Contaminación atmosférica y Medio ambiente.

1. Introduction

The year 2020 was marked in the history of humanity, becoming the year that the world literally stopped. SARS-CoV-2, new coronavirus, has caused changes in work habits, consumption, and principally, people's behavior. However, history starts last year on December 31, 2019, when the Health World Organization received warnings from the first reported cases of pneumonia in Wuhan city, located in Hebei province, Popular Chinese Republican. Subsequently, in January 2020, Chinese authorities identified a new type of coronavirus, which is responsible to cause COVID-19, that in such a short amount of time, spread through the world, causing a pandemic (Folha, 2020).

As time passes, WHO recommended that countries should do actions to stop the dissemination of the new virus, on behalf of security and social welfare. In this way, as the numbers of cases were increasing, representatives of some countries did Lockdown, in other words, an imposition of State to accomplish complete blockage, in order to promote social isolation and social distance (Folha, 2020).

This unexpected scenario caused changes in individuals' lives. New sanitary habits have become common and more frequent, protection equipment have become mandatory in public spaces, new relationships realities, works, classes started to be virtual, bringing severe transformations in all society sections. However, COVID-19 impacts didn't affect only humans, at first was noticed, from media and some scientific studies developed, during pandemic period, in earlier times, unseen climatic changes were noticed during Lockdown period.

Environmental transformations were observed, atmospherics issues came to a head, considering that concentration of particulate matter (PM) and pollutants issued in the air, during social isolation. has been showing significant falls (Gardiner, 2020). Possibly, this fact can be related to several factory closure and the lower vehicles circulation, causing a decrease in the level of air pollutants.

Fine particulate matter and nitrogen dioxide concentrations decreased significantly since January 2020, in several parts of the world. Recent data from NASA (National

Aeronautics and Space Administration) and ESA (European Space Agency) revealed a reduction in emissions of these pollutants in countries like China, South Korea, Italy, and India (Gioda et al., 2020).

> Atmospheric pollution is one of the main causes of deaths and diseases, as pollution levels increase, risk of cardiac diseases, lung cancer and acute and chronic respiratory diseases become more susceptible to reach people that live in cities, where those concentrations are high (Martin, 2020, p. 4).

In this way, existing evidences are justified in scientific articles shows that the industrials activities attenuation associated with reducing the numbers of vehicles circulating in the streets, during Lockdown period, brought benefits to air quality, consequently, established an improvement in life quality and social welfare in different parts of the world. Therefore, the present article aims to investigate possible relations between social isolation and air quality impacts in the State of Rio de Janeiro.

2. Methodology

In order to understand direct impacts in air quality, during the social isolation period in the state of Rio de Janeiro, this survey is a qualitative research, using bibliographic revies as the main technique. Sampieri, Collado and Lucio (2013, p. 33) highlights that the qualitative research consists of inductive process whose exploratory and descriptive features will generate theoretical perspectives. Therefore, seeks to analyze, in a particular way, collected data that will review obtained results and produce their conclusions.

According to Silva and Menezes (2005, p. 37), review of literature brings theoretical foundation to adress the issue encompassed by the research. Therefore, along with the qualitative survey, a bibliographic review will allow a better understanding about what has already been done on this issue. Thus, using both techniques, it was possible to trace the main sources that would bring theoretical background about this theme.

The main materials used to cover this article were searched in Google Academic and some of theorical base was found in state and federal legislations, some of them were based on news and technical standards that were released during the period analyzed.

3. Knowing more about the main air pollutants

To move forward in the discussion of the possible relationships that exist between social isolation in times of pandemic and air quality, it is important to understand what are the main elements that pollute the air, its sources and impacts on the quality of life.

We start with nitrogen dioxide (NO_2), an extremely toxic and corrosive gas, with a color that varies from brown to yellow and, in high concentrations, has a strong and irritating smell. NO_2 emissions can occur from various activities, the main sources being automotive vehicles and, in smaller proportions, industries, thermoelectric power plantas stoves, cigarettes and heaters that use kerosene (Cançado et al., 2006). NO_2 can react with water, forming nitric acid, one of the main responsible for the phenomenon of acid rain, which alters soil and water compositions, also causing the corrosion of forests and plantations (Cónsul et al., 2004). According to these same authors, NO_2 can react with all parts of the body that comes into contact, causing cell damage, however, the most vulnerable areas are those of the respiratory system, causing inflammation from the nose to the pulmonary alveoli.

Another very common compound is carbon monoxide (CO), a colorless, odorless, and tasteless gas, however, poisonous to humans. It can be produced by natural processes, such as spontaneous forest fires, volcanic eruptions, and chlorophyll decomposition. However, the most worrisome are emissions from human actions, taking as an example, automotive vehicles, thermoelectric power plants, and the chemical and oil refining industries (World Health Organization [WHO], 1999).

Regarding the effects related to CO poisoning, they can vary from headache, tiredness and nausea in mild cases, to loss of consciousness, tachycardia and circulatory and respiratory disorders in more severe cases, which can lead to death. This happens due to the binding of ingested carbon monoxide with hemoglobin (Hb), forming carboxyhemoglobin (COHb) and preventing the formation of oxyhemoglobin (HbO_2) and, consequently, the transport of oxygen (O_2) through the blood, considering that the affinity of hemoglobin with carbon monoxide is 200 to 250 times greater than the affinity with oxygen (Peres, 2005).

Another compound worth mentioning is sulfur dioxide (SO_2), a colorless, non-flammable gas, soluble in water and toxic to humans. Most of the emissions are due to the burning of fossil fuels in different plants and industries, but it can also be produced by automobiles and, in smaller proportions, natural sources such as volcanoes. It can react with water and oxygen, forming sulfuric acid, one of the main causes of acid rain, as well as nitric acid (U.S. Environmental Protection Agency [EPA], 2019).

Sulfur dioxide can cause many adverse health effects, especially respiratory complications. Exposure can lead to irritation of the skin and mucous membranes of the airways. During physical exercise in an environment with a concentration of SO_2, the effects can be worsened due to increased inhalation, which may include coughing and breathing difficulties. People with asthma and cardiovascular disease may also have their symptoms worsened (U.S. EPA, 2019).

In addition to the gases described above, there are also particulate matter (PM), which are small solid or liquid particles suspended in the air. Some of these particles can be seen with naked eye in clouds of dust or smoke, others are so small that an electronic microscope is necessary. Particulate materials can be formed from hundreds of different components, including sulfur dioxide and nitrogen oxides, which are emitted by automobiles, industrial processes, and factories. Some PMs may also come directly from a source, such as construction sites, unpaved streets, chimneys, or fires (U.S. EPA, 2018). Particles with a diameter of less than 10 μm are considered the most dangerous and are divided into coarse (PM_{10}) and fine ($PM_{2,5}$), the first being those with a diameter between 2,5 and 10 μm and the last with a diameter less than 2,5 μm (Mello, Mariani, & Sella, 2010).

The finer particles are the ones that present the greatest health risk, as they can be inhaled and can pass through the trachea, entering the lungs and, in some cases, reaching the bloodstream. Being exposed in environments with this type of particle can affect both the lungs and the heart, causing respiratory symptoms such as irritation of the airways, coughing and difficulty breathing, such as arrhythmia and tachycardia (U.S. EPA, 2020).

4. Main laws about air quality

Once the main pollutants elements present in the atmospheric air have been shown, it is also important to point out that aspects related to air quality legislation.

After the first Industrial Revolution, changes in the production process and the use of fossil energy sources have intensified atmospheric pollution around the world. Air gases pollution, such as carbon monoxide (CO) and nitrogen oxide (NO), can bring negative impacts to the environment as well as to human life. During the year of 2018, WHO published a report, which estimates that, approximately, 7 million of people die every year because of exposure to fine particulate in air pollutants. Furthermore, the same report said that the organization credits the air pollution as a critical factor for non-transmitional chronic diseases and already causes about 43% of deaths from chronic pulmonary disease.

In the SARS-CoV-2 scenario, the disease brought discussions even more careful about air pollution. That is because, in recent studies published in Science of the Total Environment journal, high levels of nitrogen dioxide, pollutant gas with big oxidant action, can lead to an increase of hospital internations. These dates can have a direct relationship with high rates of mortality of COVID-19. Parallel to this, an exposure of the population to high pollution standards has a direct effect on the lunges, creating a risk to people to develop bronchitis, asthma and even pulmonary edema. That way, lung injuries, caused by pollution, are a risk factor since people with respiratory problems found themselves in the risk group of the COVID-19. Therefore, this leads to a discussion about new forms of production, new energy policies and, most importantly, a legislation about monitoring and establishing air quality standards.

Despite the relation between greenhouse gases and atmospheric pollution being an old agenda among great nations, with protocols released during the 1990s, it still has an inefficiency about measures that guarantee reducing the pollution. For example, the Kyoto Protocol created in 1997 and implemented only in 2005, constituting a treaty between the United Nations about climatic changes. It aimed to define goals about the reduction of the emission of gases having a greenhouse effect, with the objective to reduce the impact of climatic changes and to promote a clean development. However, the low tack of the heavily emitting countries and ineffective climate Kyoto measures did not generate big impacts neither in the air quality nor atmospheric pollution (Souza et al., 2017).

Towards that scenario, this article highlights the Brazilian federal laws as well as Rio de Janeiro state laws, that are related to air quality and their indicators. It is worth mentioning that Brazil still lacks on actions to deal with air pollution and, most importantly, in their monitoring. According to a survey conducted by Instituto Saúde e Sustentabilidade in the year of 2018, only 7 from 27 federative units carry out air quality measurement programs, and when they do it, they do it inefficiently. Air pollution and the problems caused by her makes the population even more vulnerable for the contagion of the new coronavirus. In this way, the debate about legislation and the development of quality standards, besides monitoring, are extremely important for the health of the population.

In Brazil, debates about air pollution started after 1975 with the N° 1413 law. This act provides control of environmental pollution caused by industrial activities, it discusses necessary measures on prevention and damage containment caused by pollution. In 1981, the Brazilian environmental policy, law number 6939, was instituted and created the Conselho Nacional de Meio Ambiente. Its main objective was preservation, enhancement and restore

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environmental quality propitious to life, aiming to ensure, in the country, conditions on socio-economic development, interest of national security, protection of human dignity, taking account of the following principle: this law has brought the idea to control and to monitor environment quality.

Moreover, number 12.608 law instituted the creation of Programa Nacional de Proteção e Defesa Civil and Conselho Nacional de Proteção e Defesa Civil, and it has fined the development of an information system and disaster monitoring systems. Lastly, with the aim of developing an air standards system, several resolutions related to CONAMA were released. In its first version, published in 1989, the creation of the Programa Nacional de Controle de Qualidade do Ar, served as a great tool for environmental management, to protect and enhance air and life quality. The second resolution, released in 1990, carried out the definition about air quality standards, as provided on PRONAR. Its latest and most recent version, published in 2018, CONAMA Resolution provided an improvement of quality standards released in 1990, based on the values posted by WHO (Board 1). In addition, states and districts environmental organizations should develop air emission control programs based on the emission levels of pollutants, observed on (Board 2). While this, being defined by its own laws in order to create preventive measures that avoids potential health risks.

Board 1 – Air Quality Standards.

Atmospheric pollutants	Reference period	PI-1	PI-2	PI-3	PF	
		µg/m³	µg/m³	µg/m³	µg/m³	Ppm
Particulate Matter (MP_{10})	24 hours	120	100	75	50	-
	Anual¹	40	35	30	20	-
Particulate Matter ($PM_{2,5}$)	24 hours	60	50	37	25	-
	Anual¹	20	17	15	10	-
Sulphur dioxide (SO_2)	24 hours	125	50	30	20	-
	Anual¹	40	30	20	-	-

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Nitrogen Dioxide (NO_2)	1 hour[2]	260	240	220	200	-
	Anual[1]	60	50	45	40	-
Ozone (O_3)	8 hours[3]	140	130	120	100	-
Smog	24 hours	120	100	75	50	-
	Anual[1]	40	35	30	20	-
Carbon Monoxide (CO)	8 hours[3]	-	-	-	-	9
Suspended Particulate Matter (SPM)	24 hours	-	-	-	240	-
	Anual[4]	-	-	-	80	-
Lead (Pb[5])	Anual[1]	-	-	-	0,5	-
[1] - anual arithmetic mean						
[2] - hourly average						
[3] - daily maximum moving averaged obtained						
[4] - Anual geometric mean						
[5] – measured in suspended particulate matters						

Source: CONAMA (2018)

Board 2 - Levels of Attention, Alert e Emergency for Pollutants concentrations.

Levels	Pollutants concentrations					
	SO_2 µg/m³ (daily average)	Particulate Matter		CO ppm (8 hours moving average)	O_3 µg/m³ (8 hours moving average)	NO_2 µg/m³ (average hourly)
		MP_{10} µg/m³ (daily average)	$MP_{2,5}$ µg/m³ (daily average)			
Attention	800	250	125	15	200	1130
Alert	1600	420	210	30	400	2260
Emergency	2100	500	250	40	600	3000

Source: CONAMA (2018).

About the context of Rio de Janeiro, the article emphasized that the state has boosted the process of environmental licensing in the country. The first legal instrument tool was developed in 1967, through Decree 779, in which it approved the Air Pollution Control Regulation in the Guanabara State. Therefore, Rio de Janeiro has become a pioneer in environmental monitoring in the country.

Further, in 1975, the state sanctioned Decree No. 134 in which it provided for the prevention and supervisor control in the environment in Rio de Janeiro, and other provisions. Also describing penalties for those who cause damage, this decree discusses its concepts, its polluting sources and which bodies are responsible for prevention and control.

During 2013, Decree No. 44.072 was published, which regulates the quality standards of the state of Rio de Janeiro, based on national standards and the guidelines and recommendations of the world health organization, and takes other measures. This decree instituted the Instituto Estadual do Ambiente (INEA) was responsible for monitoring the state's quality, based on the concentration values by CONAMA Resolution 03/90. After the release of CONAMA Resolution No. 491 of 2018, these parameters were changed, in order to follow the standards of federal legislation and WHO.

Concomitantly, the state releases daily reports and bulletins on air quality, monitored by the 58 monitoring stations distributed throughout Rio de Janeiro, which continuously measure the following parameters: nitrogen oxide (NOx), carbon monoxide (CO), sulfur dioxide (SO_2), ozone (O_3) and hydrocarbons; volatile liquid compounds, such as benzene; and solid and liquid microparticles suspended in the air (SPM, MP_{10} and $MP_{2,5}$). Finally, INEA's monitoring networks also monitor the weather conditions that can cause the dilution and concentration of these pollutants.

5. The effects of COVID-19 on air quality during social isolation

As the advent of the coronavirus in the world occurred unexpectedly, no country, public or private institution was prepared to deal with the impacts brought about by the pandemic. Governments in all parts of the world are taking steps to combat the virus through social isolation and obtaining mechanical respirators for the Intensive Care Unit (ICU) beds. Thus, the economic situation of the countries is not the best, many places are already suffering strong economic recessions.

> According to the IEA (2020) the oil producers of the OPEC+ group reached an agreement to reduce production as of May 1, 2020, due to excess supply and accumulation of stock, stressing that even with these measures the market will not rebalance immediately (Martin & Martin, 2020, p. 7).

On the other hand, there has been a big gain on environmental issues, especially when it comes to air pollutants. With the scenario of social isolation, it was possible to notice the reduction of vehicle circulation, congestion, consumption of fossil fuels, economic power, jobs, industrial activities, and consumption in general. As an example, Martin and Martin (2020, p.8) state that "With the pandemic, coal generation has decreased drastically with the reduction and/or stagnation of activities worldwide, but the possibility of building more plants between 2021 and 2025 in China is already being discussed, which extrapolates its climate targets".

In Brazil, regions that have air monitoring stations are managing to analyze the effects of social isolation on the environment. Although the state environmental agencies do not yet have the reports for the year 2020, some technical notes and information are serving as data for the studies conducted during this period.

> Although the partial blockade in Brazil has contributed to a positive impact on air quality, it is important to take into account the negative impacts on social aspects, considering the deaths caused by COVID-19 and also the dramatic economic effects. As a lesson learned, this pandemic has brought to light the possible reduction of emissions of pollutants into the air by increasing the use of technology to expand remote working (Nakada & Urban, 2020, p. 7).

The coronavirus has brought with it many transformations that are being noticed today, where all sectors are undergoing drastic changes. For Dantas et al. (2020, p. 9), “the partial confinement of the population and the reduction of road vehicles led to a decrease in CO and NO_2 levels and, on the other hand, an increase in O_3 concentration.” This pollutant is considered one of the main pollutants in Rio de Janeiro and this increase suggests the evaluation of air quality policies in the city and the impacts of NMHC / NOx ratios on ozone levels.

According to Gioda, Beringui and Justo (2020), social isolation represented a major impact for the state of Rio de Janeiro. In order to confirm these assumptions, INEA evaluated the pollutants CO, NO_2, particulate matter, SO_2 and O_3, through the measurement of air quality and meteorology monitoring stations in Brazil. This was only possible using automatic and semi-automatic monitoring networks. The automatic stations are characterized by the capacity to process, in real time, the hourly averages of the air quality parameters, in which, later, they are validated and available daily in INEA's electronic address. The semi-automatic stations are characterized by human handling and the use of filters in the machines in order to evaluate the mass, the chemical composition and if there are toxic materials in the atmosphere. Such instruments made possible the formulation of the following technical notes:

On March 27, 2020, the Technical Note nº 19/2020/GEAR was published, with the intention of presenting four stations in the metropolitan region of Rio de Janeiro state, among them the seasons Jardim Primavera, Santa Cruz, Monte Serrat and Manguinhos, at the beginning of social isolation. In this technical norm, NO was the pollutant that got the most focus, due to the aggravation of problems related to the respiratory tract in the human being and for being a precursor in the formation of the secondary pollutant, the ozone.

Due to the extension of social isolation, another Technical Note nº21/2020/GEAR was published on April 17, 2020, aiming to complement the monitoring of air quality in the state of Rio de Janeiro, including three more stations, being Adalgisa Nery located in the west of the city of Rio de Janeiro, Engenho de Dentro in the north of Rio de Janeiro and Copacabana located in the south of Rio de Janeiro. Two more pollutants were evaluated, CO and particulate matter with a diameter of less than 10 micrometers (MP_{10}), as well as the verification of meteorological factors that could influence the elevation/reduction of concentrations of air pollutants.

Air quality monitoring stations in the metropolitan region of Rio de Janeiro presented results in some studies on the average concentrations of NO, making a comparison over the weeks of pandemic. In the first weeks showed significant reductions in the Santa Cruz and Jardim Primavera seasons, compared to a week before social isolation, due to the compliance of the suspension of activities recommended by the state.

Bangu station did not present significant changes in NO levels in the atmosphere since social isolation was not adopted as expected and its proximity to the Refinaria de Manguinhos (REFIT) may have influenced this increase. Monte Serrat station did not get many changes during this period. In the order hand, Irajá station had an increase in the second week due to weather factors, while in the third week it had a reduction and, finally, due to the easing of social isolation, in its fourth week it had an increase. However, Manguinhos resulted in the increase of this pollutant, it is believed that the aggravation was by vehicular congestion.

Carbon monoxide was analyzed in only three stations, being Santa Cruz, Engenho de Dentro and Copacabana. At the Santa Cruz station there was a reduction, but they were standardized and believed it was due to vehicle emissions. At the Engenho de Dentro station there was a minimum reduction. In specific periods, rush hours, there was an increase of this parameter due to the congestion of the cars. The Copacabana station presented a significant reduction in this pollutant, due to compliance with restrictive measures.

The MP_{10} is characterized by diesel vehicle emissions and was analyzed in two stations, being Irajá and Copacabana. In Irajá the data fluctuated a lot. This is because in its third week of analysis, there were reductions, but in the final average of the weeks studied, there were almost no changes. At the Copacabana station there was a significant reduction in the third week, but unfortunately, the following week there was an increase in MP10 levels, with a reduction in the last week evaluated, oscillations are believed to be due to vehicle and industrial emissions.

The last Technical Note Nº 23/2020/GEAR, was published on May 6, 2020, addressing air quality during the application of preventive measures in Volta Redonda, located in the municipality of the state of Rio de Janeiro. The pollutants analyzed were NO and total particles in suspension in the atmosphere (PTS), applying meteorological analyses in seven periods. To monitor air quality, three stations were analyzed in the neighborhoods of Santa Cecília, Belmonte and Retiro in Volta Redonda. The period analyzed was between April 5 and 30.

The NO was analyzed in only two stations, being them: Santa Cecília and Belmonte. This is because the Retiro station did not reach the minimum percentage of NO to be able to count in the analysis. The Santa Cecilia station had an increase in the second week, being related to the elevation of atmospheric pressure. From then until the fifth week there was the reduction of NO, however, due to the easing of social isolation in recent weeks, there was a gradual increase of this pollutant. In the Belmonte station there was an oscillation of the levels during the periods analyzed, but making a comparison between the first week, in which the preventive measures had not yet been applied, with the rest of the week, which occurred the suspension of several activities, NO levels during quarantine were reduced.

The total particulate matter in atmospheric suspension (PTS) was also analyzed in two stations, being them in the neighborhoods Belmonte and Retiro in Volta Redonda, this occurred because the data from the Santa Cecília station were still in validation. At the beginning of the analysis, at the Belmonte station, there was a reduction in the concentration of this pollutant, but due to high atmospheric pressure, there was an increase of particulate material and, due to technical problems, last week analysis could not be registered. In the Retiro station, it was possible to notice that there was a pattern in the schedules because it is believed that the vehicular flow was more intense.

An analysis of the meteorological conditions based on the INEA Technical Notes, which can contribute to the dilution and concentration of pollutants in the atmosphere, the climatic variables monitored are influenced by wind direction and speed, temperature, humidity, solar radiation, atmospheric pressure and precipitation. The stages were divided by week, starting on March 5, 2020, and ending on April 13, 2020.

At the beginning of the first week, from 5 to 13 March, a system of low atmospheric pressure was presented and, soon after, a change in the high pressure system occurred, favoring the increase of pollutant concentrations in the atmosphere. The following week, between 14 and 22 March, there was a period of instability in time, marked by much cloudiness and rain, which favored the reduction of pollutant concentration. During the third week, between 23 and 30 April, there was a period of atmospheric instability, in which high radiation and the reduction in air humidity, promoted the formation of clouds, the increase of ozone concentration and the reduction of other pollutants.

Between March 31 and April 7, the fourth week, instability in the atmosphere was still noticeable, with periods of elevation and reduction of pollutants. Between 8 and 15 April, despite having started with the time closed, because of circulation, the week ended with high temperature levels, which favored the progressive increase of concentrations of pollutants. In the sixth week, between April 16 and April 23, the climate variation occurred, but the high atmospheric pressures stood out so that the concentrations of air pollutants remained high. And in the seventh and last week, between April 24 and 31, due to the high temperatures in the atmosphere, the weather was drier, so that the increase in pollutant concentration was favorable.

6. Final Considerations

As observed in this study, CO_2, NO_2 and PM indices were reduced in some regions in Rio de Janeiro. That way, by adopting WHO preventive measures about social isolation, the State, not only reduces the numbers of COVID-19 cases, but also creates a positive impact in air quality.

However, this may be temporary since with the resumption of industrial activities, with higher vehicles and public transport circulation, those air quality indicators may improve again. Therefore, the new coronavirus brought important reflections about what marks that the humans are leaving in the environment, as well as the need to replace fossil fuels. Technology is advancing, and can be used for the environment, starting with the implementation of renewable sources to prevent the exploitation of natural resources and the degradation of the ozone layer. It is necessary to begin to change habits, getting an awareness of our ecological footprint, because without these aspects sustainability will not be sustained.

There is growing interest in sustainability (or SD) and more recently, approaches to strategies, cleaner production, pollution control, eco-efficiency, environmental management, social responsibility, industrial ecology, ethical investments, green economy, eco-design, reuse, sustainable consumption, zero waste. (Glavi & Lukman, 2007). But, there should be more than just interest, practical actions should be taken as soon as possible. So, with all of this, it will, finally, walk together with 17 Sustainable Development Objectives, reducing negative air impacts and promoting better life quality.

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