http://dx.doi.org/10.18623/rvd.v17i39.1960

COVID-19: THINKING ABOUT ITS IMPACTS ON AIR QUALITY AND CLIMATE CHANGE

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ABSTRACT

The atmosphere is one of the elements of the natural environment most impacted by humans. It directly reflects on the planet's life quality, either by deteriorating air quality or contributing to climate change. Thus, this article analyzes the relevance of the atmospheric environment as an essential element to life and the impacts on air quality related to the SARS-CoV-2, the virus responsible for the current COVID-19 pandemic. We present the causes and effects of climate changes and air pollution, suggesting how the COVID-19 pandemic has been positively and negatively related to these environmental problems. We adopted the hypothetical-deductive method, using a qualitative research approach based on literature review, analysis of documents, and information available on official data dissemination websites. The theoretical framework is based on Taylor's theory (1981), as it presents the need to create moral principles for the relationship between human beings and the natural environment. We conclude that it is necessary to rediscuss the relationship between humans and the natural world

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and to reexamine social and moral principles based on environmental principles so that future epidemics can be avoided and climate effects reduced.

Keywords: air quality; atmosphere; atmospheric pollutants; COVID-19; global warming; Taylor.

COVID-19: REFLEXÕES SOBRE SEUS IMPACTOS NA QUALIDADE DO AR E NAS MODIFICAÇÕES CLIMÁTICAS

RESUMO

A atmosfera é um dos elementos do meio ambiente natural mais impactados pelo ser humano e que gera reflexos diretos na qualidade de vida do planeta, seja pela piora da qualidade do ar, seja pelas modificações climáticas. Nesse sentido, analisa-se neste artigo a importância do meio atmosférico como elemento essencial à vida e os impactos sobre a qualidade do ar relacionados ao vírus SARS-CoV-2, causador da atual pandemia de COVID-19. O presente estudo busca apresentar as causas e efeitos das modificações climáticas e da poluição do ar, indicando como a pandemia da COVID-19 tem se relacionado com estes problemas ambientais de forma positiva e negativa. O método adotado foi o hipotético-dedutivo, com abordagem qualitativa de pesquisa baseada em artigos, análises de documentos e sites oficiais de divulgação de dados. Tem por marco teórico a teoria de Taylor (1981), que apresenta a necessidade de criação de princípios morais para a relação dos seres humanos com o meio natural. Conclui, por fim, que é necessária uma rediscussão sobre a relação ser humano e mundo natural e repensar os princípios morais e sociais com base nos princípios ambientais, para que se possa evitar futuras epidemias e reduzir os efeitos climáticos.

Palavras-chave: *aquecimento global; atmosfera; COVID-19; qualidade do ar; Taylor.*

INTRODUCTION

Public policies related to environmental protection arose in many countries after the Stockholm Convention of 1972. However, in Brazil, policies began with Law 6,938 of August 31, 1981, called the National Environmental Policy (PNMA), harbored by the Constitution of the Federative Republic of Brazil of 1988 (CRFB/1988). The latter dedicated an entire chapter to the environment, guaranteeing all Brazilians the right to an ecologically balanced environment, which, according to Cirne (2019, p. 223), "outlines the goals of environmental protection in a modern and advanced way and establishes in the Brazilian text the five common bases for the constitutionalization of the environment."

Here, we highlight the relevance of the atmospheric environment as essential to life, and the impacts that the SARS-CoV-2 virus, or simply the new coronavirus, the pathogen responsible for the COVID-19 pandemic. It caused changes in the Earth's atmosphere and air quality worldwide–even if only temporarily–and sparked new reflections on the relationship between human beings and the natural world.

> Satellite images show that the coronavirus pandemic is temporarily decreasing levels of air pollution around the world. Experts point to quarantine as the largest-scale event ever recorded in terms of reducing industrial emissions. The European Space Agency (ESA) has also detected a reduction in nitrogen dioxide (NO_2), a chemical compound that contributes to air pollution and acid rain. NO_2 is the result of emissions from cars and other industrial processes, and may, among other things, cause respiratory problems (UFJF, 2020).

The terrestrial atmosphere, or simply air, in its currently known average composition, took billions of years to stabilize in this gaseous mass that surrounds Planet Earth. It is composed mainly of nitrogen and oxygen, the latter being responsible for the development of aerobic organisms[4], which include humans and many animals, among other organisms.

Human and animal breathing is achieved by the gas exchange in the respiratory tract between free oxygen in the air and carbon dioxide eliminated by metabolism. This is an inherent function of these organisms and also guarantees life on the planet.

When aspirating the oxygen present in the air, an element that is essential to human life, impurities are also aspirated, whether particles, gases, or other contaminants of biological nature, such as bacteria and viruses.

4 Organisms that need free oxygen in the air or water to breathe.

Today, concerns about the Earth's atmosphere are divided into two main areas: those of planetary origin, such as the problem of global warming, and those related to local or regional air pollution, which impacts health and the environment locally and in general. In the first case, the anthropic activities that emit Greenhouse Gases (GHG) are the main causes, because they potentiate the natural Greenhouse Effect of the Earth's atmosphere, increasing the average temperature of the planet, generating climate changes, which in turn can result in catastrophic effects to many life forms on Earth.

Air pollution, at the local and regional levels, alters air quality, impacting health, flora, fauna, socioeconomic development, and heritage. In short, the environment in general. Aspirated particles and polluting gases cause damage to the respiratory system and other vital organs, often presenting toxicity and carcinogenic potential. Many gases add acidity to the air, damaging vegetation and heritage. This situation is aggravated by the sedimentation of heavier particles that are deposited on the leaves, making it difficult for the plants to breathe, and also accelerates wear in materials, damaging them, especially the historical and cultural assets in outdoor environments.

If, until then, environmental concerns had been guided by these changes of physical, chemical, or physicochemical nature of the air, the COVID-19 pandemic brought to light the need for concern with biological changes, since the droplets expired in the breathing process of contaminated people, containing the coronavirus, may remain suspended in the air for brief moments, or prolong, depending on the conditions of the environment, whether it is closed or open, its humidity and temperature, or whether or not wind currents are present.

This article addresses the causes and effects of climate change and air pollution, indicating how the COVID-19 pandemic has positively and negatively related to these environmental problems.

We adopted the hypothetical-deductive method with a qualitative research approach based on literature review, document analysis, and information available on official data dissemination websites. As the theoretical framework, we embrace Taylor's theory (1981), as it presents the need to create moral principles for the relationship between humans and the natural environment. Finally, we demonstrate that the COVID-19 pandemic brought negative, but also positive aspects to the relationship between human beings and the natural world, as well as an invitation for us to reflect

on the real and practical possibility of changing this relationship by creating a respectful relationship, through moral principles based on environmental principles, which can change the course of climate change in the medium and long term.

1 EARTH'S ATMOSPHERE: ESSENTIAL ELEMENT OF LIFE AND ITS MODIFICATIONS BY HUMAN ACTIONS

The terrestrial atmosphere is the layer of air that surrounds Planet Earth. It is made up of radiation, gases, and particulate matter. Its extension is kilometric and is essential for the survival of the species. The physical and chemical processes that occur in it minimize the incidence of ultraviolet radiation and are responsible for maintaining the average temperature of the Earth, allowing the development and survival of living beings. In this regard, Dias, Andrade-Neto and Miltão (2007, p. 23) state:

> The layer of radiation, gases, and particulate matter (aerosols) that surrounds the Earth and extends for hundreds of kilometers is called the Earth's atmosphere. The lower limits of the atmosphere are, of course, the surfaces of the earth's crust and the oceans. However, its upper limits are not well defined because, with the increase in altitude, the atmosphere becomes increasingly rarefied, in relation to its content of matter, until it becomes confused with the interplanetary medium. To get an idea of how materially rarefied the atmosphere becomes as it moves away from the Earth's surface, just know that 99% of its mass is contained in a layer of 32km. For comparison, remember that the Earth's radius is ≈ 6300km. The knowledge of the composition and behavior of the atmosphere has great and fundamental relevance for biological processes since physical and chemical processes that occur in the atmosphere protect organisms from exposure to ultraviolet radiation at dangerous levels, in addition to the fact that the atmosphere contains gases and components of radiation necessary for vital processes on Earth, such as breathing and photosynthesis.

The terrestrial atmosphere, didactically called Air, is basically composed of Nitrogen (78%), Oxygen (20, 8%), Carbon dioxide (0, 9%), and the rest (0, 3%) by other gases such as argon, krypton, helium, neon, radon and xenon, methane, sulfur dioxide, and water vapor (BRANCO, 1982).

We can affirm didactically that the atmosphere is divided into layers that together extend over a thousand kilometers of altitude and as they move away from the Earth's surface they become more rarefied. The boundaries of each layer are marked by inflections in temperature (PERES, 2008).

The layer called Troposphere extends from the surface of the Earth for about 15 to 18 km of altitude in the equator, and about 6 to 8 km in the

poles. This layer corresponds to 80% of the atmospheric weight and in it, the development of life and weather phenomena occur. After the Troposphere is the Stratosphere, which extends to about 50 km in altitude. This is where the Ozone layer is located, responsible for filtering ultraviolet rays. The third layer is the Mesosphere, which is located between 50 and 90 km in altitude, followed by the fourth layer called Thermosphere that extends to about 450 km in altitude. The fifth and last layer is the Exosphere, up to about 900 km in altitude, where the air is rarefied and gases escape into space (PERES, 2008).

Air is an indispensable element for life in all its forms, as the breathing of human beings and other living beings depends on free oxygen (O_2) in the air, which is necessary for gas exchange with the absorption of O_2 and release of CO_2, or its absorption for the production of oxygen by vegetables. The air composition–atmosphere–guarantees the temperature, the components for the existence of life, as well as its movement, in addition to climate regulation, which, together with several factors at the same time, can change these cycles, such as solar cycles, continental drift, volcanism, and anthropic interference.

Human interferences in the atmospheric natural processes – through the emission of gases, particles and, in biodiversity, through the change of its structure, as in the transformation of vegetation – by agriculture – or the insertion of buildings – cities –, cause changes in the natural composition of this air layer, which can cause undesirable effects on the health and life quality of living beings on the planet. These interferences can be of order, physical (particles), chemical (gases), or biological (bacteria and viruses).

Changes in air quality, whether physical, chemical, or biological, can cause environmental impacts of a global, regional, or local nature. The most classic examples of global impacts are climate change resulting from global warming and the ozone hole resulting from the emission of substances that deteriorate it, such as chlorofluorocarbons. In the case of local and regional impacts, changes in air quality due to pollutant emissions from fixed and mobile sources present in a given area, such as industries and motor vehicles, are mentioned, as well as the removal of carbon-releasing vegetation, previously fixed by its elements. This shows that the way that human beings today relate to nature has not been harmonious, raising the need for a change in the perspective of this relationship, which thus requires new ethical precepts.

In this context, changes of biological nature in the air, per se, have never

sparked considerable attention. However, with the COVID-19 pandemic, attention turns to the need to increase knowledge on this topic. When analyzing the conditions in which viruses can be suspended in droplets in the air, even for brief moments, contaminating others via breathing, or also by comprehending the environmental changes caused by human activity, it is possible to understand how SARS-CoV-2 contaminates human beings.

The COVID-19 pandemic caused the confinement of almost all of humanity, reducing industrial activities in space-time of its dissemination that leads to a reduction in emissions of gases and particles responsible for global warming and local or regional pollution. Consequently, air quality has changed, however, the positive or negative consequences of the pandemic in the medium and long term are not yet known.

1.1 Air quality

Air quality is assessed in terms of the concentration of pollutants at unnatural levels, or at levels that interfere with the natural cycle of the atmosphere in a locality or region. The measurements of these pollutants have been carried out by increasingly modern equipment, and automatic air quality monitoring stations are currently used, with mathematical data analyzed by the latest generation computers. These stations have specific sensors that measure the concentration of various pollutants in real time in the atmosphere, storing the data that is transmitted to environmental agencies and disclosed to the population. This information is also used for the construction of the historical series used to investigate its variations and better understand how to fight this pollution.

The atmospheric qualification is evaluated according to the standards defined by the World Health Organization that parameterized the definition given by the National Environment Council's (CONAMA) Resolution No. 491/2018.

> Art. 2 For the purposes of this resolution, the following definitions are adopted: II – air quality standard: one of the instruments of air quality management, defined as the concentration value of a specific pollutant in the atmosphere associated with a time interval of exposure, in order for the environment and the health of the population to be preserved in relation to the risks of damage caused by air pollution; III – intermediate air quality standards – IP: standards established as temporary values to be met in stages; IV–final air quality standard – PF: guideline values defined by the World Health Organization – WHO in 2005 (CONAMA, 2018).

Air quality standards are management tools, determined by the concentration of a specific pollutant in the atmosphere that must be associated with the exposure time, to preserve the health of the population and the environment and to understand the reasons for increases (or its absence) in the concentration of pollutants, that can lead to disease and climate change.

CONAMA Resolution No 491/2018 proposes that the final air quality standards must be based on the international scientific standards defined by the World Health Organization. However, it does not establish deadlines for reaching intermediate and final standards for each pollutant, nor the desirable values for protecting the environment and human health. These standards are references to the concentration levels for each pollutant, which, if exceeded, could endanger the health of the population. The concept of air pollution refers to the situation where these limits are exceeded. According to the World Health Organization (WHO) (2018):

> Air pollution is a major environmental risk to health. By reducing air pollution levels, countries can reduce the burden of disease from stroke, heart disease, lung cancer, and both chronic and acute respiratory diseases, including asthma. The lower the levels of air pollution, the better the cardiovascular and respiratory health of the population will be, both long- and short-term. Ambient (outdoor air pollution) in both cities and rural areas was estimated to cause 4.2 million premature deaths worldwide in 2016.

WHO estimates indicate that the majority of premature deaths that occurred in 2016, related to air pollution, were from cardiovascular accidents, lung infections, and lung cancer. However, many of these deaths can be attributed to more than one risk factor at the same time, such as the individual being a smoker or being in an environment of smokers and unhealthy environments (OMS, 2018). However, the impact of the environment on these deaths cannot be disregarded. If there is an exacerbated growth of a given disease in a given region, the environmental factor may have interfered and therefore needs to be investigated.

Thus, it is extremely important to monitor air quality to determine the level of concentration of pollutants, depending on the environmental effects they are capable of producing.

In this context, Priscila Kelly Moreira Ireno states (2015, p. 7)

> Air quality monitoring is mainly used to measure the degree of exposure of receptors (humans, animals, plants, and materials) in regions prone to a greater degree of pollutant concentration, based on the maximum and minimum concentrations defined by the CONAMA Resolution 03/90, which, when exceeded, may affect the health and well-being of the population. To this end, monitoring programs developed by the

> states are carried out, according to the legal attributions already mentioned. Its main goals are to identify possible pollution trends in a region and to adopt emergency measures in critical episodes, in order to ensure the health of the exposed population and to ensure the control of toxic atmospheric pollutants introduced by anthropic activities.

Therefore, air quality monitoring programs aim to ensure the maintenance of air quality standards at levels that guarantee health and ecosystem preservation. It is worth mentioning that CONAMA resolution 03/90 was revoked by Resolution 491/2018, which, after decades of debates, updated concepts and references, based on WHO recommendations and international experiences, although, as mentioned, it did not establish deadlines for achieving the goals necessary to protect human health and the environment in general.

The competence for monitoring air quality rests with state environmental agencies, based on the pollutants and procedures established in CONAMA resolution 491/2018, calculating and disseminating the Air Quality Index (IQA), to inform the population about the conditions of the air they breathe clearly and objectively.

This index, adopted internationally, was developed by the United States Environmental Protection Agency (EPA), being a tool that aims to transform the concentrations of the dispersed pollutants in values that allows the comparison with the standards established by the legislation. The transformation of concentrations into indices is obtained by specific calculations for each pollutant (IRENO, 2015). Current studies on this topic are essential to guarantee a healthy quality of life, and its dissemination provides information for civil society to organize itself to guarantee an adequate environment for life.

1.2 Main pollutants and sources of emissions

The control of the main pollutants considered in public policies for environmental protection has the health of the population as its main focus. However, it also refers to the fauna and flora protection, socio-economic development, and natural, historical, cultural, and landscape heritage.

> […] atmospheric pollutant: any form of matter in quantity, concentration, time or other characteristics that make or may make the air inappropriate or harmful to health, inconvenient to public well-being, harmful to materials, fauna, and flora or harmful to the security, and use of the property or normal community activities (CONAMA, 2018).

Air pollutants are divided into two major groups: particles and gases. There is also the "smoke" class that occurs when particles dissolved in gases are found.

In the case of particles, currently, the main focus is on inhalable particles, considering that the smaller they are, the more deeply they can reach the respiratory system of human beings. Thus, we have particles smaller than 10 micrometers expressed as PM_{10} and those smaller than 2.5 micrometers, expressed as $PM_{2,5}$.

> Particulate Material MP10: particles of solid or liquid material suspended in the air, in the form of dust, fog, aerosol, soot, among others, with an aerodynamic cut diameter equivalent to 10 micrometers;
> Particulate Material MP2.5: particles of solid or liquid material suspended in the air, in the form of dust, fog, aerosol, soot, among others, with an aerodynamic cut diameter equivalent to 2.5 micrometers (CONAMA, 2018).

In the case of gases, Carbon monoxide (CO), Sulfur dioxide (SO2), Nitrogen dioxide (NO2), and Ozone (O3) are highlighted.

In Brazil, air quality standards are established by CONAMA Resolution n. 491/2018, which established standards for particles, gases, and the presence of Lead (Pb) in the atmosphere, which must be monitored by state environmental agencies. According to the Brazilian Ministry of the Environment (MMA),

> The parameters regulated by environmental legislation are as follows: total suspended particles (PTS), smoke, inhalable particles (MP_{10} and $MP_{2,5}$), sulfur dioxide (SO_2), carbon monoxide (CO), ozone (O_3), nitrogen dioxide (NO_2), and lead (PB). The same resolution also establishes the criteria for acute episodes of air pollution. It should be noted that the declaration of the states of Attention, Alert, and Emergency requires, in addition to the concentration levels reached, the forecast of unfavorable weather conditions for the dispersion of pollutants (MMA, 2020a).

The new standards established, valid as of the publication of this resolution, November 21, 2018, were a little more restrictive than those that were in force since 1990. However, no new intermediate deadlines have been set, nor even the deadline for reaching the levels recommended by WHO since 2005.

The sources of emission of atmospheric pollutants can be natural or anthropic, i.e., produced by human activities. In turn, anthropic sources are divided into fixed or mobile sources, being punctual or fugitive emissions.

The State Environment Foundation (FEAM) (2015) defines:

> Emission sources can be natural (volcanoes) or anthropic (produced by man). The main anthropogenic sources of atmospheric pollutants are called fixed sources (industries) or mobile sources (gasoline/diesel/alcohol/natural gas vehicles), which may be due to external combustion (boilers, furnaces) or internal combustion (automobiles) and other processes of transformation (acid manufacturing). These sources can also be punctual (chimneys, ducts) or diffuse (non-punctual and random, that is, they do not have a specific emission point or they do not come from a specific generation site. Emissions from diffuse sources are called fugitive emissions.

Thus, a fixed anthropogenic emission source refers to the point from which pollutants are dispersed into the atmosphere, with the installation or equipment being fixed, such as, for example, industrial chimneys; The emission points can also be mobile, such as emissions from motor vehicles. Finally, fugitive emissions are those carried out by wind drag.

The main sources of air pollutants are emissions from the burning of fossil fuels in industrial processes, power generation processes (thermoelectric plants), and motor vehicles.

As principais fontes para esses poluentes atmosféricos são as emissões da queima de combustíveis fósseis em processos industriais, geração de energia (termelétricas) e por veículos automotores. We emphasize that the various processes of the extractive and transformation industry, depending on the raw materials and technologies used, present other sources of pollutants, in addition to the burning of fossil fuels, such as emissions of particulate material and gases in cement and steelmaking furnaces, and dragging of particulate material in open-pit mining.

In large urban centers, emissions from mobile sources are responsible for a large part of air pollution. Even though automobile technology has mitigated the harmful effects of engine combustion, vehicles produce harmful amounts of particulate matter. As exposed by FEAM (2020) when discussing mobile sources:

> Vehicle traffic is largely responsible for the deterioration of air quality in urban centers, where most of the world population lives today. Although vehicle emissions have been greatly reduced due to several technological improvements in engines and changes in fuels, emissions of air pollutants from the car fleet are still a factor that deserves attention, mainly due to the growth of the circulating fleet in urban areas and traffic conditions.

Although individually, this type of emission is apparently insignificant, when analyzing the number of vehicles in large cities, the generation of tons of pollutants per day is observed. Several factors influence the amount of vehicle emission in urban areas such as the types of vehicles,

the age of the fleet, the type of fuel, the number of vehicles circulating, and traffic conditions.

Many of these emissions, in addition to interfering in health and air quality in the short term, participate in the global composition of emissions that contribute to climate change in the short, medium, and long term, which demonstrates the ethical disconnection of society towards the environment in which it lives.

1.3 Greenhouse effect and global warming

The Greenhouse Effect is a natural phenomenon that is essential because it provides the necessary conditions for life on the planet. When solar radiation (light) reaches the earth, it is reflected in the form of infrared radiation (heat), part goes into space, and part is retained by gases present in the atmosphere, the Greenhouse Gases (GHG). The main GHGs are carbon dioxide (CO_2), methane (CH_4), and water vapor (H_2O), responsible for maintaining an average temperature on Earth of about 15°C, allowing the development of life on our planet (BRANCO, 1982).

> The greenhouse effect is a natural phenomenon and enables human life on Earth. Part of the solar energy that reaches the planet is reflected directly back into space when it reaches the top of the Earth's atmosphere–and part is absorbed by the oceans and the Earth's surface, promoting its warming. A portion of that heat is radiated back into space, but it is blocked by the presence of greenhouse gases that, despite allowing the energy from the Sun (emitted in shorter wavelengths) to pass through, are opaque to terrestrial radiation, emitted in greater wavelengths. This difference in wavelengths is due to differences in the temperatures of the Sun and the Earth's surface. In fact, it is the presence of these gases in the atmosphere that makes the Earth habitable, because, if they did not exist naturally, the average temperature of the planet would be very low, in the order of minus 18°C. The exchange of energy between the surface and the atmosphere maintains the current conditions, which provide an average global temperature close to the surface of 14°C (MMA, 2012).

Historically, the heat conditions of the Earth's surface have been deformed; warmer periods intercalated with less warm or glacial ones over time. However, nowadays there is a concern about the interference of human activities, which release GHG, as they may be potentiating the natural Greenhouse Effect. Thus, this temperature variation, even though it is of natural origin, may be accelerating by human interference in the environment, an issue that has been highlighted in global discussions (MENDONÇA, 2003).

The climate has shown changes throughout the history of the Planet. However, it is possible to notice that the current climate change presents particularities. In 2005, the presence of carbon dioxide (CO_2) in the atmosphere exceeded the natural variation of the last 650 thousand years, reaching a record 379 parts per million in volume (ppm), which means an increase of almost 100 ppm since the pre-industrial era (MMA, 2012). These great discrepancies, among others, led to the conclusion that this drastic change couldn't come exclusively from natural phenomena, and anthropogenic interference in the environment began to be analyzed as an influencing factor in climate change.

Among the human activities that have most contributed to global warming, the burning of fossil fuels stands out, with China and the United States being the largest emitters of CO_2. In the case of Brazil, land-use changes, especially deforestation, constitute the main reasons for emissions that contribute to climate change (IPCC, 2014).

Another factor that indicates climate change is the increase in the average global temperature of the air and the oceans, which has been causing the melting of the polar ice caps and rising sea levels. The global average surface temperatures are the highest in the last five centuries, with an increase of about 0.74°C in the last hundred years. If anthropic interference is not mitigated, a very unusual climate is expected in this century, which may present, for example, an average increase in global temperature of 2°C to 5.8°C (MMA, 2012).

Thus, human interference must be mitigated so that the normal conditions of the planet can be reestablished. This requires international cooperation to adopt measures to minimize environmental impacts. In 1992, during the Rio Conference, the United Nations Framework Convention on Climate Change was created, coming into force in 1994, and currently comprising 195 countries. This environmental treaty aims to promote international cooperation to stabilize the global climate system and contain the warming of the planet's temperature caused by the emission of GHG (REI; GONÇALVES; SOUZA, 2017).

Member countries meet annually at the Conference of the Parties (COP), the last of which, COP 25, was held in November 2019 in Madrid. Among the COPs, we highlight COP 3, held in 1997 in the city of Kyoto (Japan), when the Kyoto Protocol was signed, establishing the goal of developed countries to reduce their emissions by an average of 5.2% compared to 1990 levels until 2012. The Protocol failed in its mission, as

the results were not achieved, especially due to the non-involvement of the main GHG emitting countries. Another noteworthy highlight was the COP 21 held in 2015 in Paris, which gave rise to the Paris Agreement when the signatory countries committed themselves to establish their Intended Nationally Determined Contributions (INDC), which are expected to come into effect as of 2020. Although much less rigid than the Kyoto Protocol, the Paris Agreement involved all countries in an equal way and in an attempt to join common efforts in compliance with the principle of Cooperation between peoples, emanating from the 1972 Stockholm Convention.

Brazil assumed the objective of reducing 37% of GHG emissions by 2025 and 43% by 2030, expanding the share of renewable energy sources in the energy matrix, in addition to reducing illegal deforestation in the Brazilian Amazon to zero.

However, there are still those who do not believe in the possibility that human interference is capable of causing climate change, the so-called "climate skeptics," based on scientific studies who especially believe in glacier mini-cycles that can occur on the planet at a fast pace[5] and are unrelated to human emissions. Such research probably influences the United States, the second largest GHG emitter, to not participate in any global agreement to combat climate change, as occurred in the Kyoto Protocol and with its withdrawal from the Paris Agreement.

COP 26, scheduled to take place in November 2020 in the United Kingdom due to the COVID-19 Pandemic, has been postponed to 2021. The topics to be analyzed and discussed at this conference are already published on the IPCC website[6].

2 COVID-19: IMPACTS ON ATMOSPHERE AND AIR QUALITY

The current world scenario is characterized by the existence of a Pandemic, a viral outbreak originating in the city of Wuhan-China, with an epidemiological spread with a very fast transmission speed. In about three months, there was already a worldwide outbreak that led governments to restrict the right of movement and the free economic exercise, given the risks of contamination. Therefore, it is necessary to have a historical

5 For more information on the topic read "História geológica e Ciência do clima: métodos e origens do estudo dos ciclos climáticos na Terra" by Marcos José de Oliveira, Gustavo Macedo de Mello Baptista, Celso Dal Ré Carneiro and Francisco Arthur Silva Vecchia.

6 IPCC website: https://www.ipcc.ch/reports/.

understanding of the emergence of non-pharmacological measures that aim to mitigate the effects of the viral outbreak.

In Ancient Greece, Hippocrates, in the 5th century BC, defined that, to verify whether a disease was chronic or originated from a pathogenic agent, isolation should be maintained for forty days. The term quarantine is derived from the Italian expression "*forty giorni,*" which means forty days, dated 1377 when Europe suffered from the black plague outbreak. Faced with the possibility of spreading the disease, the ships were to remain anchored for forty days after arriving at the port of the Republic of Ragusa, a former colony of Venice, a practice that was disseminated to other ports in Italy and France in the following century. The use of quarantine in health was also recorded in the 18th century when the British government used it as a measure to control the outbreak of bubonic plague (UCHÔA; UCHÔA, 2020).

With the strengthening of relations between national states and intense international trade, public health has become an international concern that needed to be regulated, given the large circulation of people, goods, and merchandise throughout all countries. Fear of possible spread of disease led the International Health Convention held in 1926 to discuss quarantine as a possible measure for disease control. The International Health Regulations defined the concept of "public health emergency of international concern" as an extraordinary and cross-border event that constitutes a public health risk and requires coordinated responses (LIMA; COSTA, 2015).

The World Health Organization (WHO) to organize efforts to combat international pandemic medical emergencies of Influenza, already in this century, instituted the pharmacological and non-pharmacological measures that should be adopted. Lima and Costa (2015, p. 11) state:

> To control emergencies in influenza pandemics, the World Health Organization (WHO) has established strategies for pharmaceutical and non-pharmaceutical interventions, that must be initiated in the discovery of an outbreak, in addition to ethical issues that should be observed during the application of the measures. Non-pharmaceutical interventions include attention to hygiene habits, measures to restrict freedom, such as the isolation of infected individuals, quarantine of contacts, and social distancing measures, such as travel restrictions, the closing of schools and crowded places.

Non-pharmacological measures seek to reduce the speed of propagation of the viral epidemic, including measures of hygiene and mobility restrictions, which impose on the population the non-exercise

of daily activities such as circulation on public roads, travel, commerce, and industrial production. Thus, there is an attempt to reduce the rate of viral transmission speed, so that the health system does not collapse (OLIVEIRA, 2020).

The World Health Organization in the International Health Regulations[7] defined in Article No 1 quarantine and isolation as follows:

> "Quarantine" means the restriction of activities and/or separation from others of suspect persons who are not ill or of suspect baggage, containers, conveyances, or goods in such a manner as to prevent the possible spread of infection or contamination; "isolation" means separation of ill or contaminated persons or affected baggage, containers, conveyances, goods or postal parcels from others in such a manner as to prevent the spread of infection or contamination (OMS, 2005).

Thus, quarantine would be the restriction of activities, people, and objects that might be contaminated by the disease; isolation, on the other hand, would be the segregation of contaminated goods or ill people; finally, social distance is the limitation of daily activities that involve crowds, with the closing of schools, restrictions on travel, commerce, and industry.

According to some authors such as Schuchmann *et al.* (2020), quarantine and isolation are effective, as it makes it possible to identify people who are contaminated or suspected of contamination by tracking where and how they came into contact with contaminated objects and individuals. If this identification is not possible, community restraint should be adopted to minimize interpersonal contact in the affected location to build the history of the contamination cycle. Community restraint contemplates two distinct forms: horizontal (deletion) and vertical (mitigation), the latter being only the separation of patients and citizens who constitute a risk group, and the former a total restriction of movement of people, in which only essential activities should be carried out.

However, in Brazil, the term isolation has been used in general, considering "vertical isolation" as the restriction of circulation of patients and people who have characteristics that constitute a risk factor in case of contagion, aiming to mitigate the spread of the disease; and, in turn, horizontal isolation makes no distinction in the isolation criteria, applying restrictions to all citizens, with the total shutdown of mobility flows (lockdown).

As seen, in 2020, the Covid-19 outbreak forced states to adopt measures to contain the spread of the virus. Thus, following the guidelines of

7 The International Health Regulations (IHR) is an international legal instrument binding for 196 countries worldwide, which includes all Member States of the World Health Organization (OMS). Its main objective is to help the international community to prevent and respond to serious public health risks that have the potential to cross borders and threaten people around the world.

the World Health Organization, countries should adopt non-pharmacological measures appropriate to the local reality, even due to the still current uncertainty of what would be the appropriate pharmacological intervention to protect against the SARS-CoV-2 virus.

In this sense, the World Health Organization (WHO, 2020) adds:

> Depending on the answers to the three questions, a level of risk (high, intermediate, low) is assigned. Here, the risk is an overall appraisal of the negative consequences resulting from loosening measures and the capacity to manage them. The risk level may be used to guide the adaptation of public health and social measures. In the context of the COVID-19 pandemic, finding, testing, and isolating cases, contact tracing, and quarantine remain core public health measures through all stages of the response. Similarly, measures to ensure the protection of health workers and vulnerable groups must be maintained. Depending on the risk level, other measures such as community measures, restriction of mass gathering, and measures to reduce the risk of introduction of the virus must be adapted.

Thus, nations had to adapt health measures to the reality of their territories so that they were effective in combating the spread of the viral outbreak. When the viral outbreak of international concern was announced by WHO, the Brazilian government imposed rules of limitations and restrictions to control the disease, through Law no. 13,979 of February 6, 2020. The law provided "on measures to deal with the public health emergency of international concern resulting from the coronavirus responsible for the 2019 outbreak."

> Art. 3. To cope with the public health emergency of international concern resulting from the coronavirus, the authorities may adopt, within the scope of their competences, among others, the following measures: VI–exceptional and temporary restriction, by highways, ports or airports, of: a) entering and leaving the country; b) interstate and intercity transportation (BRASIL, 2020).

Such legal indication, as can be seen, was generic and did not carry out a national integration program to combat the pandemic, generating the results observed today.

Faced with the difficulties of separating ill people from healthy people, especially given the low testing levels in the country, most federative entities have adopted isolation as the measure of community containment, to ensure hospital care for those affected by the virus. Thus, the reduction in the circulation of people, goods, and services in the national territory has been causing the mitigation of atmospheric emissions and, consequently, of global warming and local and regional air pollution, since the use of emission sources have been reduced.

2.1 COVID-19 and air quality

The isolation resulting from the COVID-19 Pandemic restricted, besides the mobility of people, goods, and services, the interruption of many production activities responsible for atmospheric emissions in addition to GHG. Thus, emissions of particulate matter (PM_{10} and $PM_{2,5}$), sulfur gases (SO_2), nitrogen (NO_2), and ozone (O_3), the main pollutants that degrade air quality at the local and regional levels, also showed reductions, contributing to the improvement of air quality worldwide. Also, the low circulation of vehicles has reduced GHGs that contribute to climate change in the period of isolation established in each country.

There has been a considerable number of news in the international media about the improvement of air quality in cities in China and Europe, leading us to reflect on the role of humanity in the worsening of the environment and on our respect for the environment, responsible for providing shelter for humans.

> According to Marco Hernandez, particulate materials identified by the acronym PM2.5–which have the ability, through the lungs, to enter the bloodstream and trigger health problems such as cancer, strokes, and heart disease, released into the atmosphere mainly from the burning of fuels, suffered great decreases in the province of Hubei, China, after the imposition of restrictions on the circulation of vehicles in the quarantine (TAMANINI, 2020).
>
> Lockdowns – the total suspension of activities–carried out in some European countries as a measure to contain the effects of the new coronavirus pandemic played an important role in significantly reducing pollution levels across the continent, according to the European Space Agency. The agency reported that nitrogen dioxide levels have dropped by around 50% in some cities, with the fall coinciding with "stringent quarantine measures implemented across Europe. The improvements in air quality were most evident in France, Spain, and Italy, countries that determined strict containment for several weeks. Paris saw a 54% drop in nitrogen dioxide concentrations when comparing the period between March 13 and April 13 with the same period in 2019. Madrid, Milan, and Rome recorded decreases of about 45% (POLUIÇÃO…, 2020).

In Brazil, it was also possible to observe reductions in the levels of pollutants and an improvement in air quality in several capitals, resulting from social isolation measures. In São Paulo, for example, there was an important drop in the carbon monoxide indices, which reached the lowest rates for the period, dropping to 1 part per million against the usual 9 ppm (CETESB, 2020).

In addition, other improvements resulting from these restrictions were also noted by CETESB in the disclosure of the official website of the state government:

> Since March 20, the Environmental Company of the State of São Paulo (CETESB) has recorded, in all 29 monitoring stations in the region, good air quality for primary pollutants, which are those emitted directly by polluting sources. In addition to the smaller number of vehicles in circulation, the freer traffic conditions and the absence of traffic jams also contribute to a lower emission of pollutants. The company clarifies that the air quality is also strongly influenced by the meteorological conditions of dispersion of the pollutants (SÃO PAULO, 2020).

The Rio de Janeiro State Environmental Institute (INEA) also found an improvement in the air quality index between March and May 2020. In the metropolitan region of Rio de Janeiro, the levels of nitrogen dioxide (NO_2) in the air decreased significantly, with reduction rates of 77% and 45% in the Industrial District of Santa Cruz and Duque de Caxias respectively (INEA, 2020).

With the application of isolation measures, FEAM saw a significant improvement in air quality in Belo Horizonte with a reduction in the emission of inhalable particles, as added:

> According to Feam's Air Quality and Emissions Monitoring Department (Gesar) team, the interruption, restriction, suspension, and reduction of some activities, with emphasis on industrial activities and vehicle circulation, contributed directly to the reduction of atmospheric emissions. To assess the levels of these emissions, Gesar verified the data from stations in Belo Horizonte, whose pollution profile points to the predominance of traffic routes as the main group of emission sources, and also from Ibirité and Betim, the latter strongly influenced by industrial activity as its main polluting activity (FEAM, 2020).

Given these reported improvements, we analyzed the daily air quality reports of the cities of São Paulo, Rio de Janeiro, and Belo Horizonte in the period from 03 to 18 June 2020, as well as the reports of major international cities such as London, Paris, and New York.

The air quality survey in several cities around the world was based on data from the website Aqinc.org[8]. For the period surveyed, the reports in these cities had good IQA during most days, with some periods of regular quality.

Thus, it is possible to observe that the social isolation and interruption of many activities resulting from the pandemic of COVID-19 have been

8 Available from: https://aqinc.org/city/.

contributing to the improvement of air quality in several locations and regions.

It is necessary to emphasize that, in addition to these positive contributions, the new coronavirus may be present in droplets suspended in the air for some time, resulting from the breathing process of people contaminated with the potential for contamination of others.

Faz-se mister ressaltar, que a par dessas contribuições positivas, o novo coronavírus pode ficar presente em gotículas suspensas no ar por algum tempo, resultante do processo de respiração de pessoas contaminadas, com potencial de contaminação de outrem. This time of suspension of the virus in the air has been the subject of much discussion and research, which can be determined by several variables, such as closed or open environment, temperature, humidity, wind currents, and movement speed of the infected people.

We cannot deny that in this time of isolation because of SARS-Cov-2, it was possible to reflect on the reduction of pollution, how human beings are interfering with the environment or the conduct of practical or moral treatment towards the natural world. Although the reason for the start of the pandemic is still uncertain, the central hypothesis is that the virus has been transmitted from wild animals to humans.

2.2 COVID-19 and global warming

The high contagion power of the SARS-CoV-2 virus – Severe Acute Respiratory Syndrome Coronavirus – has been observed since its identification. Its detection occurred in the city of Wuhan, in the province of Hubei in China, and probably originated from a wet market. It causes the disease called COVID-19, also known as the "new coronavirus 2019."

> On December 31, 2019, the World Health Organization (WHO) was informed of several unusual cases of pneumonia in Wuhan, capital of Hubei Province in China. On January 7, 2020, a new coronavirus (SARS-CoV-2) was identified and confirmed, belonging to the same family that had already caused the SARS (Severe Acute Respiratory Syndrome) and MERS (Middle East Respiratory Syndrome) epidemics (SILVA *et al.*, 2020, p. 3).

According to Acosta et al. (2020), the *coronaviridae* family has four genera, but only two can cause disease in humans, having seven viral strains. However, only four strains have been causing disease, which today causes mild symptoms, in humans. The three most recent strains have

caused diseases with more severe symptoms and high mortality: MERS-CoV, SARS-CoV-1, and nowadays SARS-CoV-2.

The disease has spread to Europe, Asia, the United States, Australia, Latin America, and Africa, becoming a rapidly spreading Pandemic, causing many deaths in a short time, leading to panic in many regions. To minimize the risk of contagion, the first guidelines were for quarantine and isolation. The latter aims to prevent people from establishing contacts, especially between so-called risk groups and the former is aimed at people already infected.

These guidelines advocated by the WHO and most specialists have caused a significant reduction in the mobility of people, goods, and services on the planet, contributing to the interruption of various means of transport, consequently reducing the consumption of fossil fuels and the emission of GHG.

> The closure of factories and commerce, in addition to travel restrictions to deal with the spread of the virus, resulted in reduced CO_2 emissions, use of fossil fuels, waste generation, and use of raw materials, according to calculations by Lauri Myllyvirta, from the Centre for Research on Energy and Clean Air (CREA) based in the United States (OLIVEIRA; CAMPOS; SIQUEIRA, 2020).

To reduce the transmission of this new coronavirus, many countries have closed their borders, with international and domestic flights canceled. Many activities closed down, generating unemployment and negatively impacting GDP. “For each month, there will be a loss of approximately 2% of points in the annual GDP growth. The tourism sector alone faces a decrease in production that can range from 50% to 70%.” (CHACKABORTY; PRASENJIT, 2020).

The reduction of GHG emissions has already been considered an imperative need to contain the increase in global warming, but the various strategies adopted in international forums had not yet presented the expected results. What no one could imagine is that the emergence of a new virus is what would force the world to slow down, causing this reduction, although with high humanitarian and economic costs. However, in the long term, it can lead to the discussion of the effectiveness of reducing these emissions with lesser impacts, if planned and carried out in a coordinated and collective way by the world community, generating a new revolution in the relationship with the environment, possibly with new rules of conduct, as envisioned by Taylor (1981).

According to Lauri Myllyvirta (2020), a researcher at the Centre for

Research on Energy and Clean Air (CREA), China's CO_2 emissions, the world's largest GHG emitter, in May 2020 were 6% below the levels emitted in May 2019.

In the case of Brazil, as already mentioned, the main source of CO_2 emissions into the atmosphere is the change in land use, notably illegal deforestation in the Amazon. In this case, the COVID-19 Pandemic had no mitigating effects; on the contrary, forecasts for deforestation data in the Amazon point to continued growth, also due to the emergency change of focus to reduce the pandemic and its health impacts.

The monitoring of deforestation in the Amazon is carried out by a satellite system, called PRODES, which presents its annual results, ending in July. Thus, data for the pandemic period are not yet available. However, another system created to alert on deforestation and support the inspection of environmental agencies, DETER, also operated by INPE, reports the increase in deforestation foci (4,090, 28 km2) until mid-July 2020 (INPE, 2020).

An accurate assessment of the effects of the Pandemic on global warming will only be possible through the next report of the Intergovernmental Panel on Climate Change (IPCC), part of the United Nations Environment Program (UNEP), scheduled for 2021. The IPCC was responsible for disseminating information on the risks of global warming, in the last report was published in 2014.

2.3 What to expect in the post-pandemic for air pollution

As shown, in the COVID-19 pandemic that started in December 2019 and that continues to date, many discussions around the relationship between human beings and nature, technology, the community, the economy, and other human beings were carried out. Acosta *et al.* (2020, p. 202), for instance, state:

> The application of the concept of planetary health enables means for a new development model, one in which the most striking trends are driven by forces of equity, balance, and efficiency, built with respect for the integrity of natural systems, for ethics in the coexistence between people and, above all, with the perception that the planet and all its components–beings and systems–are inexorably interconnected and share a common destiny.

A change in relation to these issues is expected since the current way of using biodiversity is exploratory in such a way that it starts to threaten

human existence. The hope is that by understanding the human impact on the planet, which can be thought of by refraining from carrying out activities in this period, the relationship between human nature and nature can be rethought. It was found that nature can recover in the absence of humans and that it is possible to have a more ethical and moral relationship between the parties. Thus, one acts in agreement with Taylor (1981), on the need for the human being to think about committing to certain normative moral principles that would form rules of conduct and character parameters to relate to the natural world. This, in turn, could initially be based on the environmental principles that emerged from the 1972 Stockholm Convention and the 1992 Rio de Janeiro Convention. It is not a matter of love, but respect for nature so that we can create responsibilities centered on the life of all beings on the planet, maintaining life in all its forms..

SARS-CoV2 arises from unthinkable environmental change. According to several authors, (PLOWRIGHT *et al.*, 2017, LIU *et al.*, 2020; XIAO *et al.*, 2020 *apud* ACOSTA *et al.*, 2020, p. 192), there is strong evidence that the consumption of wild animals has led to the emergence of COVID-19. As stated by Acosta *et al.* (2020), this is because it is a disease that originated in animals. Other diseases have already arisen from this contact, including rare diseases in animals such as Ebola, for example, so the closer the proximity between wild animals and humans, the more easily infectious agents circulate.

Climatic changes can also lead to a picture of new epidemics, as the melting of certain areas can revive viruses that have attacked humans in the past or even change the cyclical relationships of life that can bring new epidemic diseases.

> Climatic changes alter the expression of the atmospheric patterns of the seasons, being able to displace and even increase periods with climatic conditions favorable to infections. The climate is a primary factor for ecological niches, determining the areas of species distributions. Climate change degrades the suitability of habitats, which in certain situations force species to disperse to new locations. The virus, due to its condition as a mandatory parasite, disperses with the species, leading and increasing the risk of spillover to new areas and other species (ACOSTA et al., 2020, p. 206).

At this moment, when the world is on a general pause, the pandemic should be seen as a moment to spark reflection on the state of the planet, and propose a more adequate relationship between living beings and the natural environment.

It is time to rethink our duties towards living beings in general. In the words of Taylor (1981, p. 6):

> We can say that the actions one performs and the character traits one develops in fulfilling these moral requirements are the way one *expresses* or *embodies* the attitude in one's conduct and character. In his famous essay, "Justice as Fairness," John Rawls describes the rules of the duties of human morality (such as fidelity, gratitude, honesty, and justice) as "forms of conduct in which recognition of others as persons is manifested." I hold that the rules of duty governing our treatment of the natural world and its inhabitants are forms of conduct in which the attitude of respect for nature is manifested.

This reduction in GHG emissions and pollution showed the possibility of change. The question is whether humanity wants to change or to stay on the inconsequential path that was in the individual–individual and individual–natural-world relationships. Only the will can generate a change in ethical standards for thinking about the environment before the situation becomes uncontrolled and can lead to the end of human life as it is known today.

FINAL REMARKS

One of the biggest current environmental problems is global warming resulting from the potentiation of the natural greenhouse effect by the emission of GHG by several anthropic activities, mainly the burning of fossil fuels, which is still the main energy source in the world energy matrix.

The efforts that have been made by member states since Rio 92 with the creation of the Climate Convention and the annual meetings of member states (COP) have not yet had the desired effects to control the increase in the average temperature of the Earth. The Kyoto Protocol (1997) failed and the Paris Agreement (2015) is encountering difficulties, with the non-commitment of major polluters such as the United States, one of the largest GHG emitters.

What no one imagined is that a virus that appeared in China at the end of 2019, SARS-CoV-2, also known as the new coronavirus, the pathogen of the pandemic of COVID-19, would be able to paralyze the world, reducing many human activities, mainly the burning of fossil fuels and consequently GHG emissions. It shows that we can reduce emissions at a cost that can be mitigated if planned in the medium and long term, although in

Brazil there has been no change since emissions are linked in particular to illegal deforestation in the Amazon. According to data from the DETER alert system, the number of deforestation foci has been increasing, even during the COVID-19 pandemic period, which shows the need to reevaluate Brazil's relationship with the Amazon.

With regard to air quality at local and regional levels, improvements are observed in all cities surveyed in the country and in the world, with a reduction in the concentration of the main pollutants, certainly due to the isolation policy recommended by WHO and adopted by most national governments. In addition to reducing the burning of fossil fuels, the reduction in the mobility of people, goods, and services has reduced many activities in industry, commerce, and services, which can also impact climate change in the medium term.

If, on the one hand, the isolation caused by the pandemic has been successful in the atmospheric environment in terms of reducing GHG emissions and other pollutants, as well as bringing reflection to the current relationship between human beings and the natural world, on the other hand, it causes concern about the capacity of new Coronavirus to remain in suspended droplets and contribute to the contamination of the population and generate major economic and social impacts throughout its occurrence. The future is not clear, but it is possible to perceive that a rediscussion about the human-natural world relationship is necessary, with a transition to new moral principles, based on an environmental conscience that can prevent future epidemics and reduce the climatic effects, based on environmental principles advocated by the main environmental conventions or the new internationally proposed behaviors as the objectives of sustainable development (SDGs).

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Article received on: 09/18/2020.
Article accepted on: 11/24/2020.

How to cite this article (ABNT):
RIBEIRO, J. C. J.; CUSTÓDIO, M. M.; PRAÇA, D. H. P. Covid-19: thinking about its impacts on air quality and climate change. *Veredas do Direito*, Belo Horizonte, v. 17, n. 39, p. 249-279, sep./dec. 2020. Available from: http://www.domhelder.edu.br/revista/index.php/veredas/article/view/1960. Access on: Month. day, year.