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Effects of the Covid-19 Pandemic on the Environment: A Brief Critical Review

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ABSTRACT
The emergence of the new coronavirus resulted in the COVID-19 pandemic, which led several countries to adopt restrictive measures, such as the lockdown. As a consequence, several changes were observed in social, commercial, industrial and environmental dynamics. Thus, the present study aimed to make a brief review of some of the main effects of the Pandemic on the environment, in different parts of the world, gathering this information in a single document. To this end, a qualitative method was adopted, in which bibliographical surveys from scientific articles were carried out, as well from articles, news and reports from reliable sources. According to the sources consulted, the impacts observed in the air were mostly positive, resulting in the reduction of the concentrations of most of the atmospheric contaminants. With regard to water resources, positive effects were detected, such as the improvement in water quality in several places in the world, as well as negative effects, portrayed in the increase of the insertion of new aquatic contaminants, of difficult synthesis, in addition to the increase of residues, harmful to the marine fauna. The increase in the volume of waste, due to the new consumption habits imposed by the Pandemic, has also shown to influence soil properties. Finally, it is possible to conclude that the health crisis is linked to the cultural habits of a society that should seek to establish more harmonious relationships with the environment.

KEYWORDS: COVID-19. Environment. Environmental impacts.

1 INTRODUCTION

According to the World Health Organization (WHO), pandemics result from the worldwide spread of a new disease or, even, when an outbreak or epidemic, which affects a certain region of the globe, spreads over different areas and continents, being its transmission made from person to person (SCHUELER, 2020).

In this sense, Cheval *et al*. (2020) highlight six major events, pandemic and epidemic, that occurred in the world between the years 2000 and 2020, namely: Severe Acute Respiratory Syndrome (SARS-CoV) (2002 to 2004), Avian Influenza (2008 to 2014), Influenza H1N1 (2009), Middle East Respiratory Syndrome (MERS-CoV) (2012 to 2020), West African Ebola Virus Epidemic (2013 to 2016) and Zika Fever (2015 to 2016). However, according to the authors, none of these illnesses reached the dimension taken by the so-called "New Coronavirus" (CHEVAL *et al*., 2020).

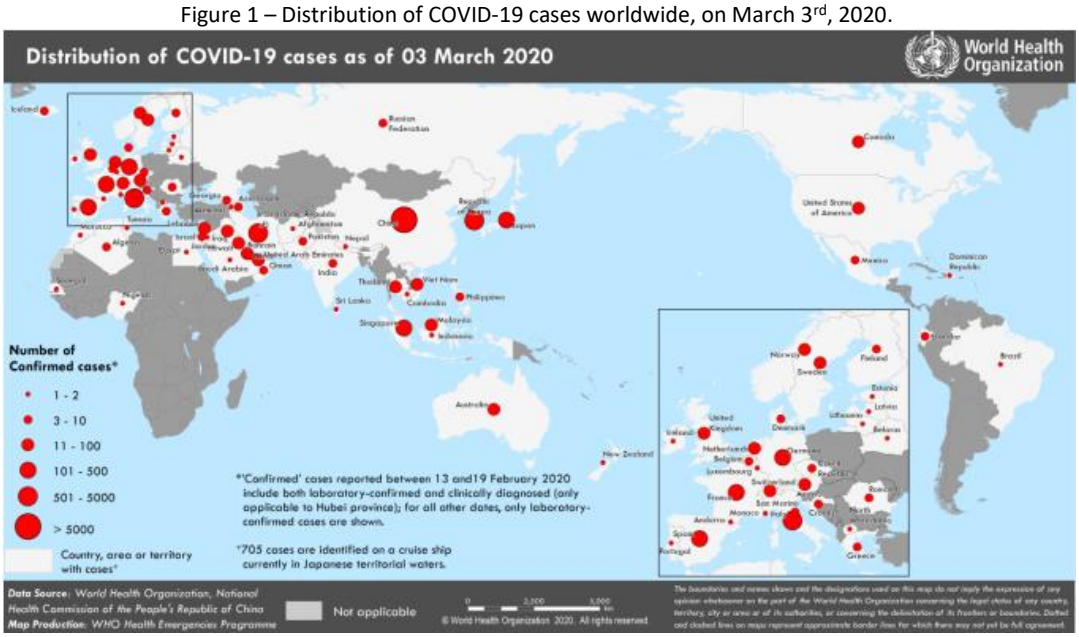
The expression "New Coronavirus" refers to a severe acute respiratory syndrome coronavirus-2 (SARS-CoV-2), and is explained by the fact that there are hundreds of viruses belonging to the coronavirus family, although only six of them are related to mild to severe illnesses that occur in the respiratory tract of humans, including SARS-CoV and MERS-CoV. As this new virus was first identified in December 2019, in the city of Wuhan, China, it became known as coronavirus disease 2019, or COVID-19 (LONE & AHMAD, 2020).

Due to the high population density of the city of Wuhan, with more than 11 million inhabitants, the virus quickly spread, and symptoms of the disease were observed more and more frequently. In some cases, the development of symptoms was quickly controlled, without evolving into major problems. However, several people had more severe conditions, evolving to complications that included organ failure, septic shock, edema and other pulmonary conditions, until death (SOHRABI, 2020).

The most impressive thing about this situation was the speed with which the virus was spreading, the high capacity of transmission and the speed with which mild symptoms evolved into more severe cases. The medical and scientific communities were surprised by a new disease, for which much of the knowledge was derived from other coronaviruses. However, COVID-19 had an amazing destructive power, incomparable to the other viruses in the family (SOHRABI, 2020).

In January 2020, WHO declared COVID-19 as a case of international public health, threatening several countries, especially those with precarious health systems (WHOa, 2020; SOHRABI, 2020). As can be seen in Figure 1, in March 2020, cases of COVID-19 were already reported in several places around the world, which led the WHO to officially declare, on March 11th, 2020, a pandemic of the New Coronavirus, which has led to an ongoing global crisis, whose consequences, despite already being partially evidenced, are still unknown (CHEVAL *et al*., 2020; WHOb, 2020).

Figure 1 – Distribution of COVID-19 cases worldwide, on March 3rd, 2020.



Source: World Health Organization (WHOb, 2020).

As a result, the world was forced to change, especially with regard to the entire lifestyle of populations. Adaptation measures and restrictions in the economic, industrial and transport sectors, as well as in society in general, had to be taken, in order to contain the advance of the virus, or even "flatten" the contamination curve. In this sense, actions such as closing borders, travel restrictions, social distancing, self-isolation and quarantine became measures not only local, but also international, which presented the best results in combating the spread of the virus (DA CONCEIÇÃO SILVA *et al*., 2020; DE SOUZA, 2020; NICOLA *et al*., 2020).

The suspension of several activities, the reduction in the movement of people and means of transport, as well as the retraction of consumption habits, a reflection of the installed financial crisis and the consequent drop in production, were reflected in results for health, economy, society and environment. Therefore, this study aims to gather information about the main impacts of the COVID-19 pandemic, with the environment as its main focus.

2 OBJECTIVES

The main objective of this research is to carry out a brief bibliographical review of some studies carried out so far on the consequences of COVID-19 for the environment. Thus, it is expected to gather, in a single document, information on the main environmental impacts

observed in the world, in different spheres, such as soil, air, water, interactions with wildlife, among others.

3 METHODOLOGY / METHOD OF ANALYSIS

The method of analysis of this study can be classified as qualitative, in the context of which a survey of bibliographical material regarding the topic addressed was carried out. Thus, a documentary and bibliographical research was carried out, based on the consultation of several scientific articles, news from reliable sources, instructive documents from national and world entities of indisputable credibility, as well as articles from newspapers and magazines from verified sources, among other relevant sources.

4 RESULTS

The results presented in this topic consist of the synthesis of the information gathered from the research carried out.

According to several scholars, the COVID-19 pandemic is a reflection of human interference in nature. Some of these researchers argue that this interference was mainly due to the removal of wild animals from their natural habitat, for commercial purposes. Others claim that globalization, and the consequent expansion of urban centers, degradation of the natural environment and destruction of habitats, were the reasons that led human beings to come closer and closer to wild animals. As coronaviruses are zoonotic organisms, that is, they are transmitted from animals to people, it is possible to perceive the dangers associated with this proximity, regardless of their origin (DE OLIVEIRA *et al*., 2020; DO NASCIMENTO *et al*., 2020).

In a study published in 2007, Cheng *et al*. (2007) alerted to the discovery of a virus from the coronavirus family, whose host was a species of bat. According to the authors, economic growth in southern China has led to an increase in the demand for food, particularly protein, and, consequently, the trade of these animals for food purposes began. The researchers highlighted that the lack of biosecurity measures and proper hygiene and eating habits would be the main factors that led to the transmission of that virus from animals to humans.

The authors also highlighted the capacity of transmission of that virus, from human to human, and the impact that the disease caused on health, economy and society in general, in a few months, in 2003. The most interesting thing about this study is that the authors alert to the possibility of further mutations, even stronger, of this already so powerful virus, if wildlife market practices in southern China were resumed (CHENG *et al.,* 2007). Twelve years after the publication of this study, the world was devastated by the biggest pandemic in recent history, caused precisely by a coronavirus.

For researchers who argue that globalization, as well as the expansion of societies towards natural habitats, are the main responsible for COVID-19, the solution to prevent the occurrence of new outbreaks in the future is to maintain an ecologically balanced environment, with preservation of environmental reserves. These authors claim that the destruction of natural environments means that wild animals have to move to urban spaces, crossing borders that have always existed between humans and the environment, thus

increasing their proximity and, consequently, facilitating the transmission of various zoonoses (CHAVES & BELLEI, 2020; DO NASCIMENTO, 2020).

Regardless of whether the origin of COVID-19 was due to one cause or another, or even a combination of both, the fact is that, indisputably, the predatory interaction of human beings with the environment is among the main causes of the occurrence of the Pandemic. The consequences, or impacts, of COVID-19 on the environment will be presented below, divided into subtopics, according to the sphere to which they belong.

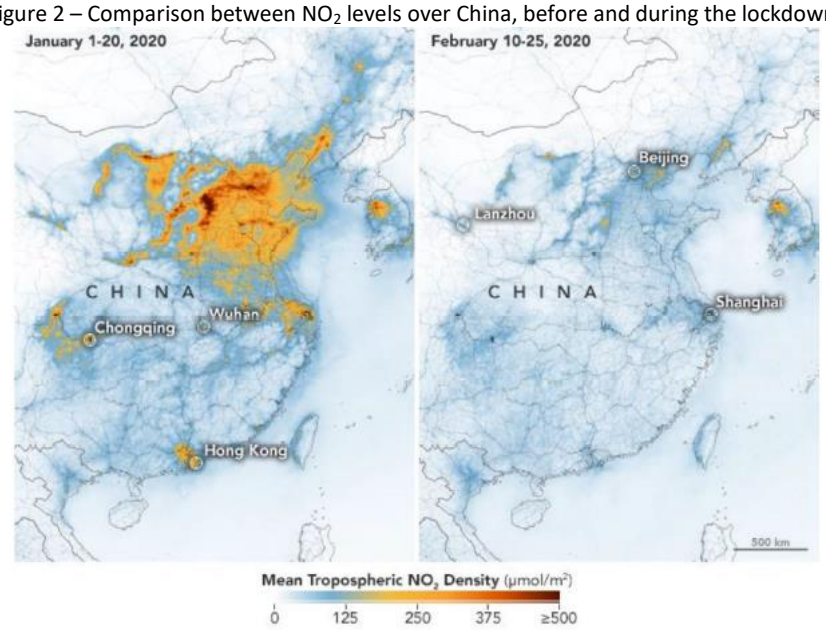
4.1 Effects on Air Quality

As the atmosphere is extremely sensitive to human activities and the emissions resulting from such activities, it is natural that one of the main spheres to present responses to the new conditions imposed by COVID-19 is the air quality. With the reduction, and even shutdown, of some industrial activities, in addition to the reduced circulation of vehicles that use fossil fuels, responsible for carbon dioxide (CO_2) and nitrogen dioxide (NO_2) emissions, air quality in many parts of the world has improved significantly. This has been shown in some media, and it can also be observed through satellite images (DE OLIVEIRA, 2020; SILVA *et al*., 2020).

According to the *National Aeronautics and Space Administration* (NASA) and the *European Space Agency* (ESA), air pollution in some countries, such as China, Spain, Italy, the United States, among others, was reduced by up to 30% during the lockdown periods (MUHAMMAD *et al*., 2020).

In China, the concentrations of atmospheric pollutants, such as NO_2, emitted mainly by vehicles, industries, and power generation plants, had a sharp decrease, when compared to the same period of the years 2015 to 2019 (SILVA *et al.,* 2020). The effects of the lockdown in the country can be clearly observed in Figure 2, which consists of satellite images showing the NO_2 levels over China at two moments: before the lockdown (January 1st to 20th, 2020) and during the lockdown (February 10th to 25th, 2020).

Figure 2 – Comparison between NO_2 levels over China, before and during the lockdown.



Source: *Earth Observatory* (*National Aeronautics and Space Administration*, NASA).

In Europe, considerable reductions in the emission levels of air pollutants have also been observed, mainly in countries such as Spain, Italy and France, where mobility was reduced by up to 90% during the lockdown period (MUHAMMAD *et al*., 2020).

In the United States, significant reductions in carbon monoxide (CO), nitrogen dioxide (NO_2), sulfur dioxide (SO_2), and particulate matter $PM_{2,5}$ and PM_{10} were also observed during the lockdown period, when compared to the same period of the previous year (SHAKOOR *et al*., 2020). On the other hand, a study carried out in the United States, which considered about 20 factors that could influence the mortality rate from COVID-19, indicated the existence of a close relationship between particulate matter $PM_{2,5}$ pollution and the risk of death from COVID-19 (ESPEJO *et al*., 2020), which clearly demonstrates the influence of air quality on human health.

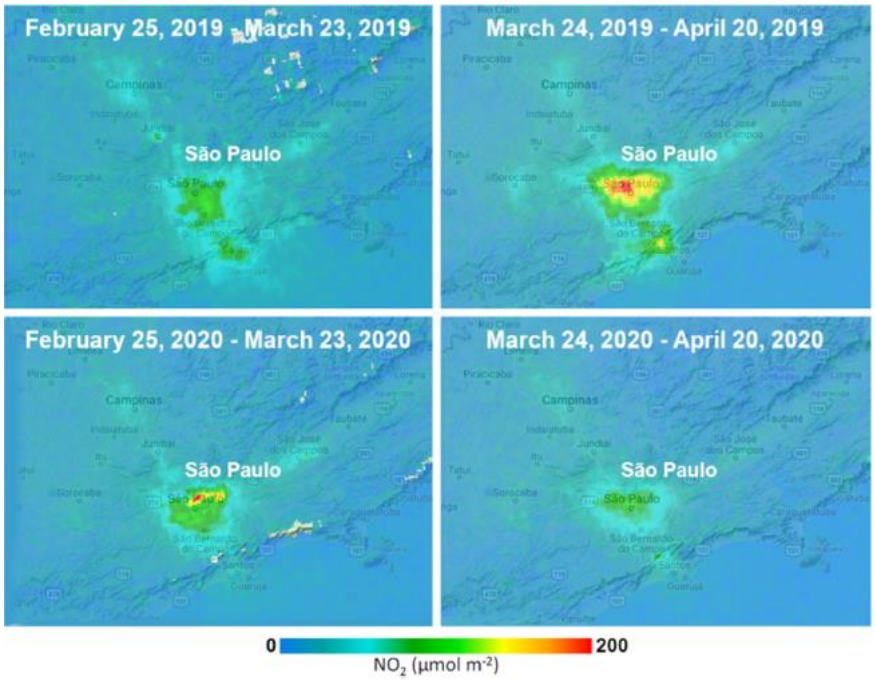
In India, studies have also been carried out to assess the effects of lockdown on air quality. In the city of Ghaziabad, the second largest industrial hub in Uttar Pradesh, as a result of restrictions on human activities, such as transport and industrial activities, there was a significant decrease in the concentration of air pollutants, reaching an 85% reduction in the concentration of $PM_{2,5}$ in the city, which is considered one of the most polluted in all of India (LOKHANDWALA & GAUTAM, 2020).

In Brazil, the effects of the reduction in human activities, as well as social isolation, on air quality were also observed in several capitals. According to the Ministry of Health, the Federal District was the first to take measures to control the dissemination of the coronavirus, through the suspension of on-site classes in the public education system, followed by the cities of Rio de Janeiro and São Paulo, where the lowest levels of carbon monoxide were registered for that period (RIBEIRO *et al*., 2020; SILVA *et al*., 2020).

Nakada and Urban (2020) observed in their studies that, during the partial lockdown carried out in São Paulo, the concentration of air pollutants dropped considerably, resulting in significant improvements in air quality, as can be seen in Figure 3. This figure shows the average NO_2 levels over the previous four weeks, and over the four weeks during the partial suspension in São Paulo, compared to the same period in 2019. The authors also emphasize that the conditions favorable to the dispersion of atmospheric contaminants were the same

before and during the isolation period, which leads to the conclusion that such conditions were not determinant for this atmospheric improvement (NAKADA & URBAN, 2020).

Figure 3 – Average NO_2 levels before and during the partial suspension in São Paulo, compared to the same period in 2019.



Source: Nakada & Urban, 2020.

Studies carried out in the Brazilian northeast region also point to the positive results arising from measures of social isolation, considering the shutdown of the industrial sector, and the reduction in the circulation of people and vehicles. Studies also point to lower NO_2 emissions throughout the region, coinciding with the period of greatest restrictions. On the other hand, increases in nitrogen dioxide rates were observed, associated with the gradual reopening of trade and the resumption of industrial activities (FIGUEREDO *et al*., 2020).

In a publication carried out by Siciliano et al. (2020), in which the city of Rio de Janeiro was evaluated, it is demonstrated that, in the short term, reductions in the emission of primary contaminants were observed, as a result of the restrictive measures. Results similar to these were observed in 2018, during the strike of the truck drivers, which lasted 10 days. (DANTAS *et al*., 2020).

However, the authors noted that the concentrations of ozone, a major secondary contaminant, remained unchanged or even increased. A possible explanation for this fact may be related to the local topographical and climatic particularities, the movement of air masses in the city of Rio de Janeiro, or even the possible increase in the reactivity of the mixture of Volatile Organic Compounds (VOC). The authors then conclude that, although some pollutants, such as particulate matter and NO_2, have shown significant reductions, it is important that the analyzes also include all air pollutants that have some impact on human health (SICILIANO *et al*., 2020).

4.2 Effects on the Soil

The main impacts of COVID-19 on the soil are closely linked to issues of food insecurity, resulting from the interruption of the supply chain. The health crisis leads to the economic crisis, with consequences in the increase of unemployment and the risk of food crisis, mainly for the poorest strata of the population. Some authors predict an exponential increase in the number of people suffering from hunger in the world after the Pandemic (COSTA *et al*., 2020; BERNARDES *et al*., 2021). This scenario, in addition to the social issues involved, can intensify deforestation processes or even generate increased pressure on productive areas, which can lead to the occurrence of erosion processes (ZAMBRANO-MONSERRATE *et al*., 2020).

Another effect of the Pandemic on the soil concerns the production and disposal of solid waste. Incorrect management of such waste can lead to contamination of the soil and, consequently, of the groundwater. The lockdown has reduced the number of people circulating and frequenting restaurants and other establishments, while commercial restrictions have caused consumers to increasingly opt for online shopping or ordering by delivery. As a result, the number of packaging and disposable materials increased considerably, aggravating the problem related to the disposal of solid waste (ZAMBRANO-MONSERRATE *et al*., 2020).

Furthermore, due to the COVID-19 pandemic, some countries, such as the United States, chose to discontinue their recycling programs, fearing the risk of contamination by the virus in recycling centers. In other countries, such as Italy, the management of solid waste was restricted (ZAMBRANO-MONSERRATE *et al*., 2020), representing a setback in the accomplishments achieved through the establishment of public policies for solid waste management.

The disposal of solid health waste (SHW) is also a matter of great concern. With the Pandemic, the number of hospitalizations and hospital admissions increased immensely and, consequently, the volume of hospital waste produced followed this increase. The habits of common citizens have also changed, it became essential that the entire population wear protective masks, often disposable. In Wuhan, China, clinical waste has increased fourfold, reaching 200 tons a day (KLEMEŠ *et al*., 2020; SAADAT *et al*., 2020).

4.3 Effects on Aquatic Systems and Water Resources

The waters of the canals of Venice, Italy, gained prominence in the world's media when photos were published that made a comparison between the month of April 2019 and the month of April 2020. Figure 4 shows something unprecedented for over 60 years: the clean and crystalline waters in the canals, due to the reduction in the movement of people, especially tourists, and boats (ESA, 2021).

Figure 4 – Lockdown effects in the city of Venice, Italy. Image comparing April 2019 with April 2020.

Source: ESA, 2021.

In India, due to the implementation of restrictions to contain the spread of the New Coronavirus, the waters of the River Ganga were considered fit for drinking. This improvement in quality is mainly related to the closing of the industries, and the consequent interruption of the discharge of their effluents directly into the river. After this considerable improvement, fish and other marine life could once again be seen in its waters (NEWS 18, 2020).

On the other hand, as negative effects of the Pandemic, an increase in PPE, such as masks and disposable gloves, was reported on beaches in Asian countries (Saadat *et al*., 2020) and on the seabed (CNN, 2020). Recent evidence shows that microplastics can reach remote regions of the planet, and also reach our bodies, through food intake and breathing (Allen *et al*., 2020).

Furthermore, the use of disinfectants in public environments has been a practice employed by some countries during the pandemic (Atolani *et al*., 2020). Triclosan is classified as an emerging contaminant (Wang et al., 2017), therefore, excessive use of this and other disinfectants can have harmful effects on health and the environment. Other dangerous contaminants are Hydroxychloroquine and Chloroquine, some of the drugs that have been used to treat COVID-19. These drugs have been described as persistent, bioaccumulative and dangerous for aquatic organisms (Ramesh et al., 2018), however, conventional effluent treatment systems do not have adequate processes for the treatment of these drugs.

4.4 Effects on Ecological Systems

According to Aragão *et al*. (2020), the DETER System, of the National Institute for Space Research (NISR), detected, between August 2019 and May 2020, an accumulated area of more than 6.000 km² with deforestation alerts in the Brazilian Amazon, an area almost twice

as large as that observed in previous years, for the same period of time. These results indicate a situation that conflicts with the suspension or reduction of activities in the most diverse sectors of the economy. According to the author, a possible explanation for these results may lie in the flexibilization of the legal instruments that controlled the advances in deforestation in the Amazon, which occurred during the Pandemic.

Associated with deforestation is the slash-and-burn agriculture, which aims to create new agricultural areas. This scenario is even more serious when associated with the Pandemic scenario. The practice of slash-and-burn agriculture releases several gases into the environment, which cause, in addition to climatic problems, respiratory diseases, leading to an increase in the number of hospitalizations and bed occupancy in a health system that is already in collapse (ARAGÃO *et al*., 2020; DA SILVA *et al*., 2020).

In 2019, deforestation caused by fires in the Amazon increased by about 30%, with projections for the following year being even more significant, according to some researchers. The destruction of natural environments as a result of human activities leads to greater proximity between wild animals and human beings. Greater contact between species makes it easier for a zoonotic virus to be transmitted from animals to human beings. The loss of these habitats makes the natural control of viruses difficult, favoring the emergence of zoonotic diseases, new viruses or even the occurrence of mutations in viruses that have already been identified (PERROTA, 2020; RABELLO *et al*., 2020).

Evidence of this is the discovery of a new strain of the virus, present in the Brazilian Amazon region, the strain B.1.1.28, which circulates in the state of Amazonas since April 2020. In Manaus, the emergence of this strain was associated with mutation with the European and African strains of the virus, with important genetic alterations, which are associated with the virus evasion of the immune response and with the increase in transmissibility and reinfection by COVID-19. In October 2020, in Rio de Janeiro, another mutation of the B.1.1.28 strain was associated with the ability of the COVID-19 virus to escape antibodies capable of neutralizing it (MICHELON, 2020; NAVECA *et al*., 2020).

5 CONCLUSION

According to most of the studies presented, the impacts of lockdown, as well as social isolation, even if partial, were reflected in a considerable improvement in air quality, noticeable through the decrease in the concentrations of the main air pollutants. On the other hand, the relaxation of restrictive measures, contrary to the WHO recommendations, resulted in a new increase in the concentration of these indicators. Air pollution causes the aggravation of respiratory diseases, leading more people to seek medical care, resulting in an overload of the health system, which is collapsing in most countries due to the increase in bed occupancy by patients with COVID-19.

Social isolation measures, together with the reduction in economic and tourism activities, the closing of borders and the quarantine, also resulted in an improvement in the quality of water resources, observed in several countries around the world.

On the other hand, these measures led to a change in the consumption habits of populations, favoring online purchases and, consequently, generating greater volumes of solid waste. The intensification of activities in the health sector also favored the accumulation of waste, which can contaminate the soil and water, in addition to affecting aquatic and

terrestrial fauna. The issue of solid waste requires good management in order to minimize the impacts of the Pandemic in the most diverse environmental spheres.

According to several researchers, the New Coronavirus pandemic was caused mainly by the devastation of the environment, with the suppression of natural habitats, which led humans and wild animals to establish a very dangerous close relationship, since coronaviruses are related to zoonotic diseases, that is, transmitted from animals to humans.

Finally, it was possible to perceive, through the health crisis that the world is going through, the fragility of health systems and the need for greater investments in research programs. In addition, the need to adopt new cultural habits is highlighted, which favor a more harmonious relationship between human beings and the environment.

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