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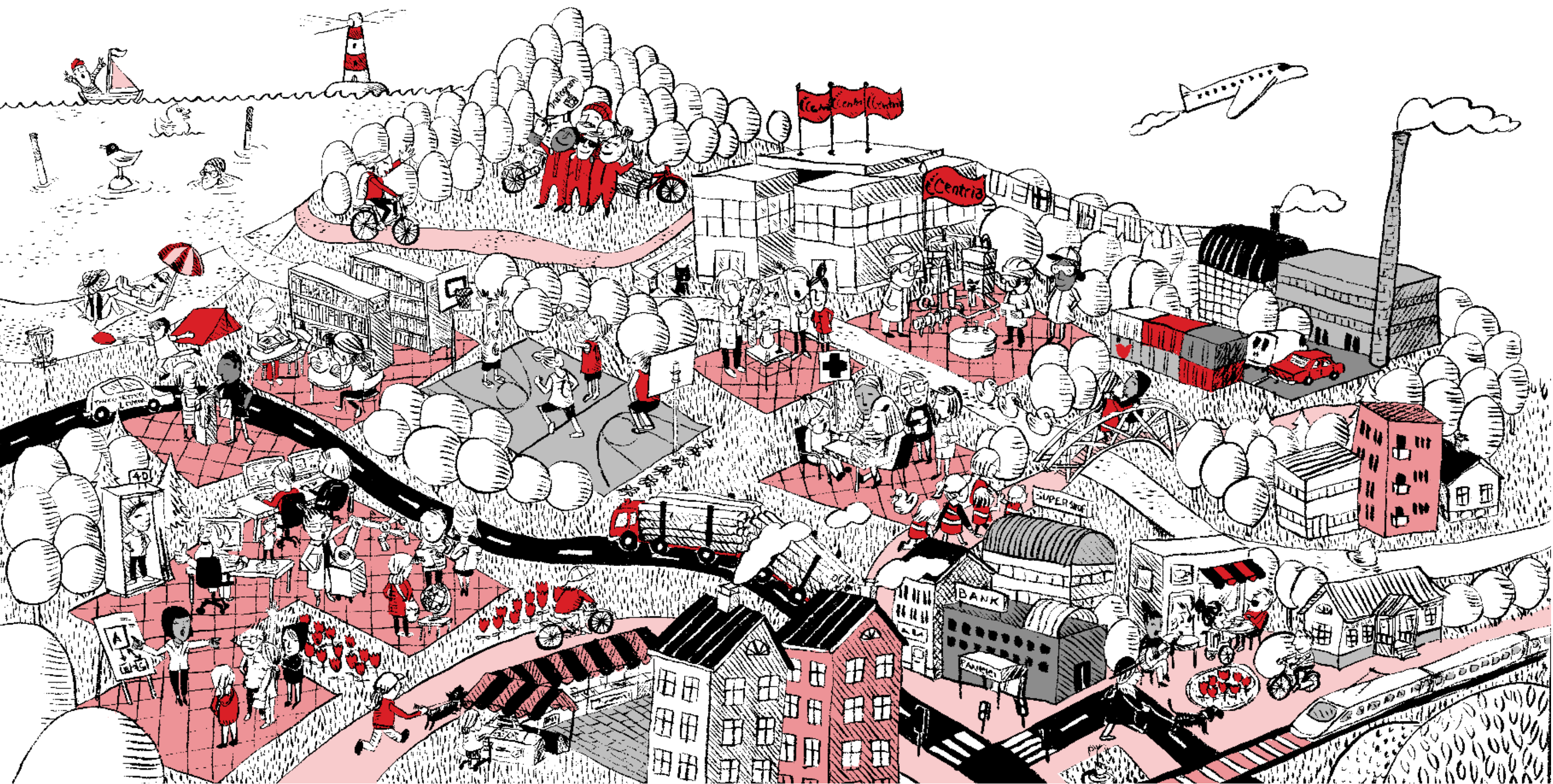
# THE INTERACTION BETWEEN COVID-19 AND ENVIRONMENTAL POLLUTION

**Thesis**

**CENTRIA UNIVERSITY OF APPLIED SCIENCES**

**Environmental chemistry and technology**

**January 2022**



**ABSTRACT**

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|---|---|---|
| **Degree programme** Environmental chemistry and technology | | |
| **Name of thesis** THE INTERACTION BETWEEN COVID-19 AND ENVIRONMENTAL POLLUTION | | |
| **Centria supervisor** Jana Holm | | **Pages** 23 + 5 |


In 2022, COVID-19 is still affecting human normal life. As a result of lockdown policies, human activity has been greatly reduced around the world. But in order to fight the epidemic, a lot of supplies have been consumed all over the world. Since the COVID-19 outbreak, the spread of the virus has slowly changed the world in many ways.

However, environmental factors are also quietly influencing the spread of the epidemic. The purpose of this thesis is to explore the relationship between the spread of the epidemic and environmental factors, and to accurately find the connection between the suppression of the spread of the epidemic and environmental protection. Lessons learned from this outbreak can be used to curb the spread of disease and promote environmental improvements.



**Key words**

COVID - 19; environmental factors; transmission. environmental health

## CONCEPT DEFINITIONS

### COVID-19

COVID-19 (Corona Virus Disease 2019), also known as "COVID-19", is named by the World Health Organization as "coronavirus Disease 2019", referring to pneumonia caused by novel coronavirus 2019 infection.

### SARS

Severe acute respiratory syndrome is an acute respiratory infectious disease caused by SARS coronavirus. The World Health Organization named it as severe acute respiratory syndrome. The disease is a respiratory infectious disease, the main mode of transmission for close droplets or contact with respiratory secretions of patients.

### WHO

The World Health Organization is a specialized agency under the United Nations, headquartered in Geneva, Switzerland. Only sovereign countries can participate. It is the largest intergovernmental Health Organization in the world.

### GWR

Geographically weighted regression (GWR) is a spatial analysis technique that is widely used in geographically and relevant disciplines of spatial mode analysis. By establishing local regression equations at each point in the spatial range, GWR explores the spatial changes and related driving factors of the research object at a certain scale, and can be used to predict future results. Because it considers the local effects of space objects, it has the advantage of higher accuracy

**ABSTRACT**

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**CONTENTS**

## 1 INTRODUCTION

COVID-19 (Corona Virus Disease 2019) has been confirmed to be transmissible from person to person. The large-scale spread of COVID-19 occurred during The Chinese New Year, with the mass movement of people accelerating the spread of COVID-19. As of 19:54 AM CET on 25 January 2022, the latest data on the WHO website shows that the number of confirmed cases worldwide has reached 3,5279,6704. The number of deaths reached 5,600,434. At the time of the COVID-19 outbreak in early December 2019, academia and citizens knew little about the spread of the virus, leading to a lag in effective response to the outbreak. In January 2020, the World Health Organization declared a global health emergency due to the rapid rate of infection in mainland China and other parts of the world.

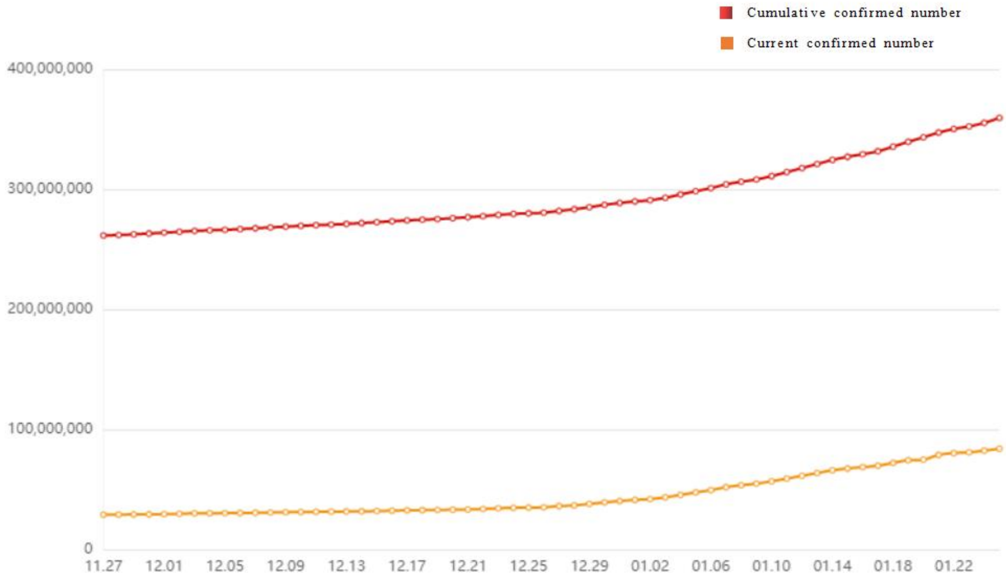


Figure 1. Global COVID-19 confirmed cases statistics. (World Health Organization 2022)

Figure 1 shows the spread of the virus between 27 November 2021 and 22 January 2022. It is clear from the data that novel Coronavirus is spreading rapidly around the world, showing a frightening trend, and that the prolonged spread of COVID-19 has had a global impact on human health and the economy. In this case, in order to stop the spread of the disease, most countries are actively responding to the spread of the emerging variant. Recent literature suggests that effective management of the virus through mass lockdowns has limited its spread, thereby indirectly improving the overall environmental quality of the world. During the global lockdown, air pollution decreased significantly. Studies show that as confirmed cases have grown exponentially, governments in different countries have imposed lockdown restrictions to limit the spread of the virus. Depending on the severity of the COVID-19 outbreak in the region, Chinese government has instituted regulations for businesses such as travel restrictions, social distancing, and the closure of industries and markets. But during the pandemic, huge amounts of supplies have been used around the world. It is estimated that 3,467 million face masks are used in China every day, and this medical waste and the massive spraying of disinfectant water will also cause considerable environmental pressure. (Wang, Liu & Zheng 2020.)

Meanwhile, environmental quality also has a significant impact on the spread of COVID-19. According to AQI, PM2.5 and PM10 have a significant positive impact on COVID-19. Viruses are usually transmitted through the air, but they can also be transmitted through waste water. Wastewater monitoring has been shown to be helpful in assessing disease transmission, which can be transmitted from sewage by workers exposed to the virus.(Cabral, 2010.)

The purpose of this thesis is to study the interaction between environmental factors and COVID-19 during the period of the epidemic. The "Discussion and Future Perspectives" section highlights the necessary links between environmental governance and the fight against COVID-19. The thesis will use figures and real examples to discuss the interaction between COVID-19 and the environment.

## 2 THE IMPACT OF COVID-19 ON THE ENVIRONMENT

The outbreak of the novel coronavirus has had a huge impact on the production and life of human beings. People even can not walk out to live normally. While the novel coronavirus has an impact on human beings, it has also quietly had a great impact on the Earth's environment.Impacts include impacts on air quality, water quality and medical waste. But these effects are summed up as environmental effects.

### 2.1 Impact on air quality

To contain the outbreak of COVID-19, the Chinese government has introduced strict quarantine measures, including strict traffic controls and self-quarantine measures for citizens. The Chinese government has designated different risk areas for different quarantine policies. The first is region, with streets and towns as the basic units. The second is the time, the longest incubation period of 14 days is a unit. Third, the epidemic situation, how many cases, whether clusters of outbreaks. The criteria are whether a street has been diagnosed with COVID-19 in 14 days, and how many. The specific criteria should be adjusted according to the situation and changes of the epidemic. High-risk areas: more than 50 cumulative cases, clusters of outbreaks within 14 days. Stroke risk areas: new confirmed cases within 14 days, cumulative confirmed cases not more than 50, or cumulative confirmed cases more than 50, no cluster of outbreaks within 14 days. Low-risk areas: no confirmed cases or no new confirmed cases for 14 consecutive days. Transport emissions fell sharply after the nationwide travel ban was implemented in all risk areas, while residential heating and industrial emissions remained flat or fell slightly. (Sarfraz, M., Mohsin, M. & Naseem, S. 2022.)

At present, scholars mainly study the impact of epidemic control measures on air pollutant concentration changes by comparing environmental air pollutant concentrations at different stages before and after the epidemic and combining meteorological parameters. Different pollutants such as $PM_{2.5}$, $PM_{10}$, $SO_2$, $NO_2$, CO and $O_3$ come from different sources. Among them, particulate matter $PM_{2.5}$ and PM10 are derived from soot generated by fuel combustion, dust generated in the production process, one-time discharge of buildings and traffic, and also contain secondary particles generated by atmospheric precursors such as $SO_2$, NOx and hydrocarbons through complex physical and chemical reactions. $SO_2$ mainly comes from the burning of sulphur-containing fuels and is used by industrial owners in steel, thermal power and ceramics. In addition, the burning of bulk coal is also an important source of $SO_2$. Anthropogenic sources of $NO_2$ mainly come from the combustion process of fuel, and automobile and other mobile sources contribute the most to emissions. $O_3$, as a secondary pollutant, is generated by the precursor NOx and volatile organic matter through photochemical reaction and is controlled by the influence of the change of solar radiation intensity. CO is the most abundant pollutant in cities, which comes from incomplete combustion of hydrocarbons, such as emissions from residential coal burning and vehicle exhaust. (Wang, Liu & Zheng 2020.)

The researchers took daily concentrations of nitrogen dioxide ($NO_2$) and $PM_{2.5}$ for 367 cities in China.Changes in air quality before and during quarantine in 2020 were then calculated and compared with corresponding changes during the same lunar calendar period from 2016 to 2019. The researchers found that because of quarantine, nitrogen dioxide ($NO_2$) in Wuhan and nationwide decreased by 22.8 $\mu g/ m^3$ and 12.9 $\mu g/ m^3$, respectively. In Wuhan, $PM_{2.5}$ dropped 1.4 $\mu g/ m^3$ and 18.9 $\mu g/ m^3$ among 367 cities. Figure 2 is a satellite image of the mean density of nitrogen dioxide tropospheric columns before and during quarantine in 2020, which shows a sharp decrease in airborne nitrogen dioxide ($NO_2$) levels across the country during quarantine. (Chen, Wang, Huang, Kinney & Anastas 2020.)

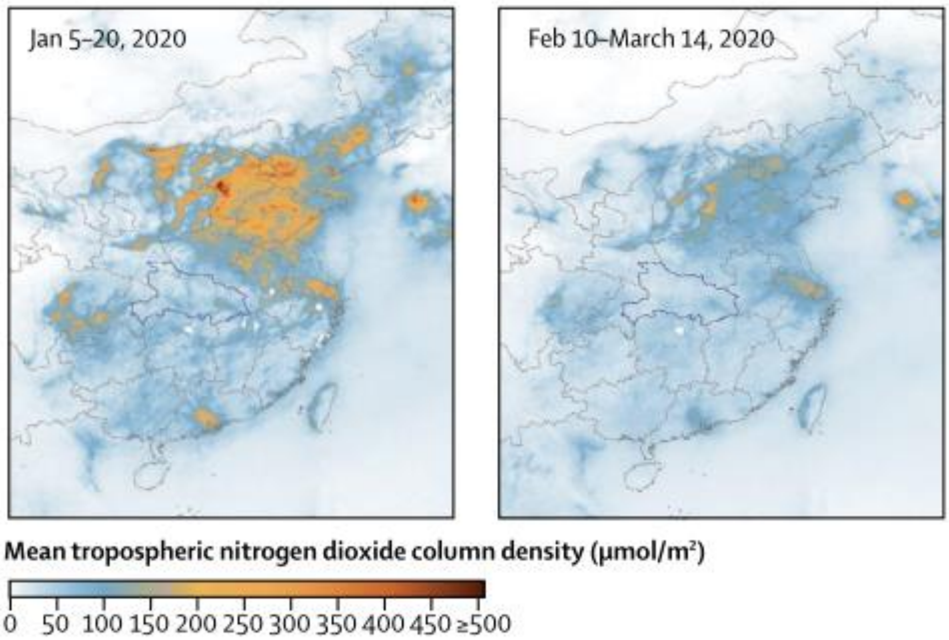


Figure 2. The mean nitrogen dioxide tropospheric column density before and during the quarantine period in 2020. (Chen, Wang, Huang, Kinney & Anastas 2020.)

Global carbon emissions are down as a result of the COVID-19 pandemic. According to Rob Jackson, a professor of Earth system science at Stanford University in the US, global carbon emissions from the fossil fuel industry could be cut by a record 2.5 billion tonnes in 2020, down more than 5% year-on-year, the Guardian reported. (Stanford Earth Matters Magazine 2020.) According to data from Norway's Resta Energy, large-scale industrial production and human life have come to a halt as a result of the multi-country lockdown to contain the Novel Coronavirus. The strict lockdown regime has "saved" billions of barrels of oil, trillions of cubic meters of natural gas and millions of tons of coal, resulting in "historic" reductions in fossil fuel emissions. With about 99,700 commercial flights a day, passenger traffic could fall by an average of nearly a quarter by 2020. Gasoline and diesel demand will also fall by an average of 2.6 million barrels a day, or 9.4 percent. Many regions are getting a chance to see clean skies again, as cities are locked down and carbon emissions plunge. (Andolu Agency, 2020.) In China, the number of "good air" days in 337 cities increased 11.4 % from the same period last year, according to the BBC. Pollution levels in New York have also fallen by nearly 50 %. Global carbon emissions in 2020 are set to fall for the first time since a 1.4% drop in the 2008 financial crisis and the biggest drop since the second World War. One even suggested that "neither the collapse of the Soviet Union, nor the various oil shocks or savings and loan crises of the past 50 years, have had the same impact on carbon emissions as this pandemic."(Greenspaces, 2020)

## 2.2 Impact on water environment

Novel Coronavirus belongs to β coronavirus and its genetic characteristics are significantly different from those of SARSR-COV and MERSR-COV. There are currently no direct data on novel Coronavirus resistance, and based on previous knowledge of coronaviruses, all classical disinfection methods should be effective in killing coronaviruses. Therefore, during the epidemic, the spraying of disinfectant water as an effective method of killing bacteria has been widely used around the world. The Chinese government has stipulated a strict disinfection system. Designated persons are required to conduct comprehensive disinfection and cleaning at designated times every day in public places, so as to suppress the spread of viruses as much as possible and kill germs that may survive in public places. ( National Health Commission 2020.)

During the epidemic, large amounts of disinfectant were sprayed on public places. A worker in Taiyuan, China, reportedly sprayed nearly 2,500 kg of disinfectant over 50 days in accordance with regulations. The use of a large amount of disinfection water inhibits the spread of the virus, but it also brings no small harm. Studies have shown that long-term and massive use of disinfectants and sterilizers will cause resistance of microorganisms, greatly reducing the sterilization effect, and more chemical substances remain in the environment, becoming a new source of pollution. Science has proven that such substances remain in the environment for a long time, and will enter the food chain, through bioenrichment, resulting in potential harm to human health. When excessive disinfectants directly or indirectly enter or are brought into the air, water and soil by rainwater, they not only cause secondary environmental pollution, but also destroy the ecological balance of the air, water and soil. As it is known that there are a huge number of microorganisms living in the air, water and soil. From the principle of biological chain, some microorganisms are beneficial and indispensable "decomposers" in the environmental medium. Commonly used chlorine-containing disinfectants can kill various microorganisms such as viruses, fungi, tuberculosis bacilli and bacterial spores. After entering the air, water and soil directly or indirectly, they will kill these beneficial and indispensable "decomposers" while killing harmful bacteria, which will inevitably destroy the biological chain relationship in the environmental medium. Disinfection by-products contain trihalomethane and other carcinogenic chlorinated organic compounds, which may increase the concentration of chlorinated organic compounds in water and increase the risk after they enter rivers, lakes and reservoirs. When the concentration of residual chlorine in water exceeds a certain value, it may cause strong corrosion to the fish mucous membrane. When the concentration of residual chlorine continues to rise, it will pose a threat to the life of some sensitive fish. (Parveen, Chowdhury & Goel ,2020.)

### 2.3 Impact of medical waste on the environment

Medical waste refers to the direct or indirect infectious, toxic and other hazardous waste produced by medical and health institutions in the course of medical treatment, prevention, health care and other related activities. Improper disposal of medical waste will cause different degrees of pollution to soil, water and air, and then harm human health and ecological balance. With the development of medical and health care and the improvement of family health awareness, the amount of medical and health waste produced by hospitals, scientific research institutes and other related medical institutions is increasing year by year. (Encyclopedia of Public Health, 2008.)

Medical waste is directly or indirectly infectious and other dangerous waste produced by medical institutions in the process of medical treatment, prevention and health care. Medical waste usually contains a large number of bacteria and viruses, and improper treatment will certainly cause secondary infection and environmental pollution. Its harm will seriously affect human health. Medical waste in China is usually divided into pathological waste, infectious waste, chemical waste, hazardous waste and pharmaceutical waste. (Padmanabhan, & Barik, 2019.)

Medical waste must be handled safely and properly. If it is not properly handled, resulting in the accumulation of waste in the outdoor, not only will occupy a large amount of land, resulting in the reduction of available soil resources, but also a large number of other toxic waste or wastewater exiled in the surrounding nature and easy to contact with the soil. Some simple medical services directly bury medical waste, which will cause a lot of soil pollution.(Padmanabhan, & Barik, 2019.)

Single-use masks and gloves, as well as protective clothing, plastic contamination of single-use medical personal protective equipment, if not disposed of properly, can have a more serious and widespread impact. Entering freshwater system or marine system, it will degrade in the system and form various parts of microplastic pellet, which will cause serious impact on marine life in seawater and destroy the normal chemical communication of the ecosystem. (Forbes, Tunby & Orcutt, 2020)

Firstly, among the toxic and harmful substances into the water, the premise will cause water quality deterioration, causing harm to human drinking water, harm to health. Secondly, it will affect the normal growth of aquatic organisms, and even eliminate aquatic organisms, and seriously damage the ecological environment of water bodies. Therefore, medical waste is rich in heavy metals and man-made substances, which are mostly stable and cannot be decomposed. Once the water is polluted, it is difficult to recover. Medical waste is rich in infectious bacteria, once it comes into the water, it will quickly cause the rapid spread of infectious diseases, while the consequences are unpredictable. (PubMed Central, 2018.)

In the process of medical waste accumulation, under the action of temperature and moisture, some organic components decompose and produce toxic gases. Some medical waste itself is rich in a large number of volatile substances, and will spontaneously combinate in the process of accumulation, releasing $CO_2$, $SO_2$ and other gases, which not only damage the environment, but also cannot be rescued once the fire spreads. Medical waste stored in the case of particles will fly in the wind and spread far away in the wind, which will not only damage the environment and affect physical health, but also contaminate buildings, flowers, fruits and trees, affect the city appearance and health, and expand the area and scope of harm. (World Health Organization, 2018.)

In addition, in the transport and treatment of medical waste, if strict containment measures are not adopted, the toxic gas and dust generated are also very serious. Toxic gases and dust spread into the atmosphere will not only cause the deterioration of the atmosphere, but also into health and other ecosystems. It will also endanger human health and the ecological environment.(Waste  medic, 2020.)

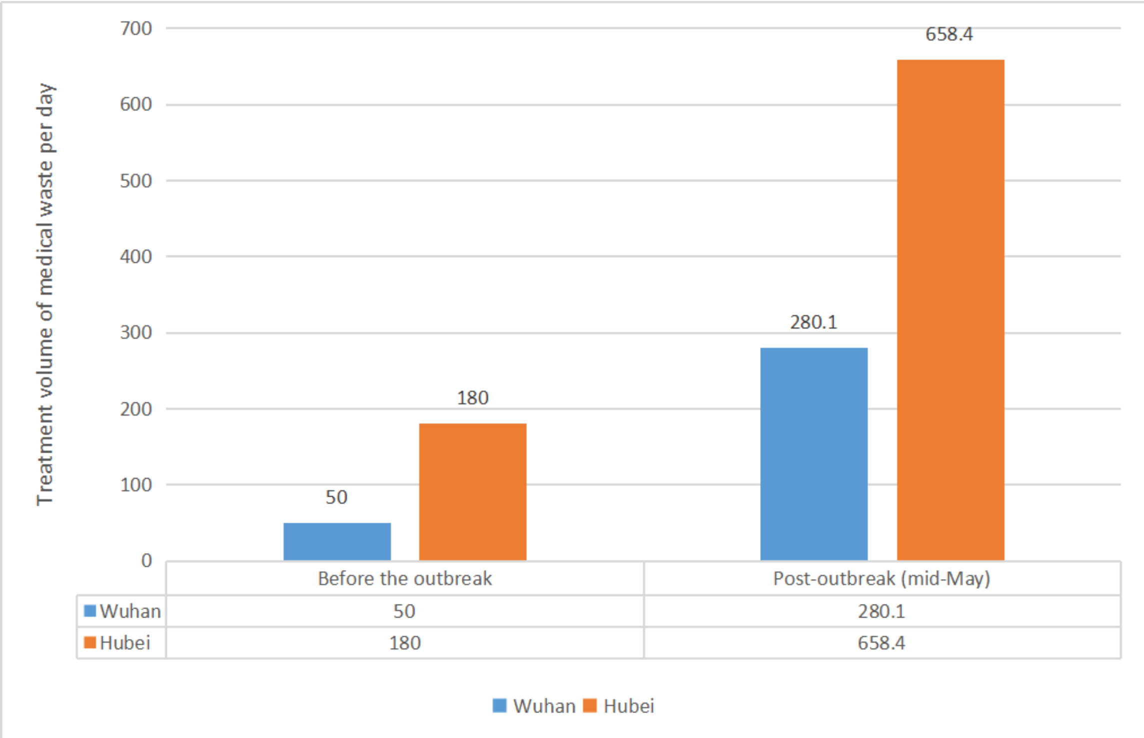


Figure 3. Comparison of medical waste disposal capacity before and after COVID-19 in Hubei and Wuhan, China. (China Daily, 2020.)

After the outbreak of COVID-19 in 2020, medical waste generated by various provinces and cities in China has skyrocketed, and the safe and effective disposal of medical waste is facing a severe situation. According to the Relevant information of the Ministry of Ecology and Environment, Wuhan produced more than 240 tons of medical waste every day during the peak of the epidemic, which was about six times the normal amount. Therefore, the treatment of medical waste becomes more important. (Nabi, Wang, Hao, Khan, Wu, & Li, 2020.)

With the encouragement of the Ministry of ecological environment, a number of environmental protection enterprises have strongly supported the medical waste treatment industry. From figure 3 it can be seen that in a short time, the medical waste treatment capacity of Hubei Province has been greatly improved. This has greatly solved the problem of a large increase in medical waste caused by the epidemic and alleviated the pressure on the environment. (Nabi, Wang, Hao, Khan, Wu, & Li, 2020.)

High temperature incineration is the main method of medical waste treatment. The processing methods mainly include: on-site processing, cluster processing and central processing. For the incineration method, the emission control of flue gas pollutants should be strengthened, especially the standard emission of dioxins and heavy metals. The non-incineration treatment of medical waste mainly includes high-temperature steam disinfection, chemical disinfection and microwave disinfection. It is mainly used for the treatment of small medical waste, mainly in prefecture level or county-level cities. Incineration is widely used in cities above the provincial capital, which is suitable for large-scale centralized treatment of medical waste. For non-incineration methods, it is important to ensure thorough disinfection and that deformed medical waste will not eventually enter the market and be processed into other plastic products. However, the generation of a large amount of medical waste will have a significant impact on the environment of covid-19 pandemic. (Global Environmental Facility, 2013.)

# 3 THE IMPACT OF ENVIRONMENTAL FACTORS ON COVID-19

With regard to the route of transmission of novel Coronavirus disease, there are currently no known respiratory protective fluids and close contact, which are currently the main known route of transmission. Since many COVID-19 patients show clinical symptoms such as fever and cough in the early stage, and even have hidden initial clinical features or "atypical" symptoms, and a certain number of infected people have asymptomatic infectious infection and individual super-spreaders, whether the coronavirus itself can survive on the surface and in the low-temperature cold chain environment. These are important risk factors for the possibility of super transmission events and cluster outbreaks. The transmission of novel Coronavirus diseases is more complex and variable, involving a variety of social and environmental factors, including human behaviour, the ecological environment and personal hygiene practices. The transmission of novel Coronavirus diseases, on the other hand, may be factors affecting regional transmission, such as drinking water and sewage. (Pica & Bouvier, 2012.)

## 3.1 The impact of water environment on the spread of COVID-19

There are many ways of transmission of viral infectious diseases, but water is an important vector of viral transmission in the occurrence and epidemic process of many viral diseases. Many viruses can live in water/sewage for a long time and spread with water flow. They can be ingested by humans by contaminating drinking water or food, entering the body by contact with mucous membranes or wounds, or they can be inhaled by humans through droplets or aerosols. It has been reported that almost all emerging viruses can be transmitted through water. In the past viral disease occurrence and epidemic process, water transmission has also become an important way of virus transmission. Many of the water-borne viruses found so far can enter water through feces. Domestic sewage is an important source of water viral pollution due to the large amount of virus in the feces excreted by infected people. (Cabral, 2010.)

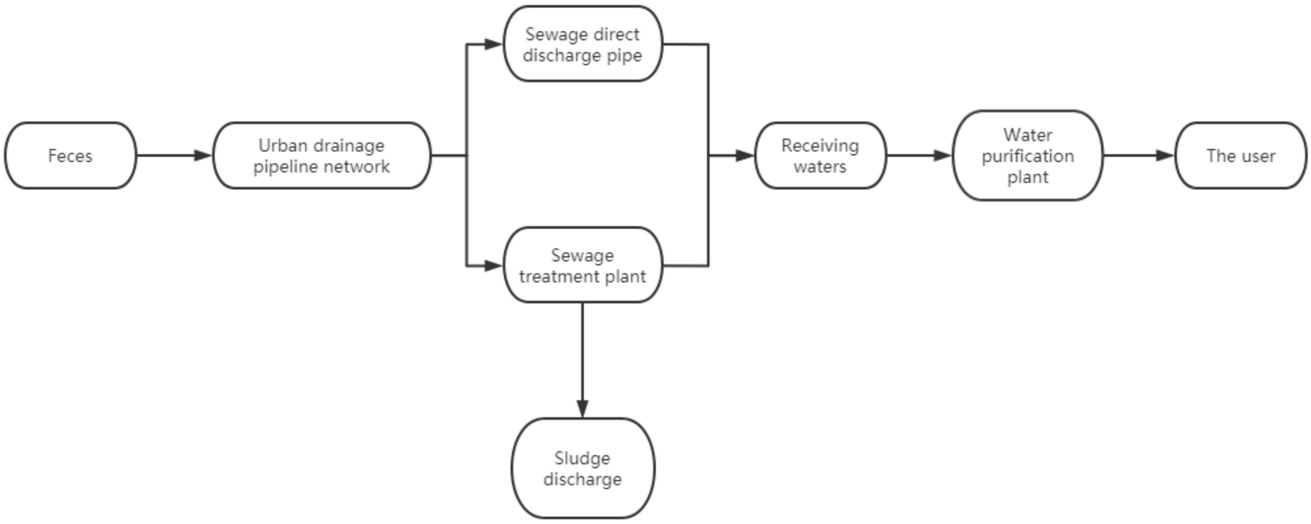


Figure 4. Transfer trajectory of COVID-19 in daily water environment

Figure 4 shows the process of daily sewage treatment and recycling in ordinary cities. In this process, there are many risk nodes for the possible spread of COVID-19. First, the area where the patient lives/is being treated is an area with a high risk of infection for contacts. When sewage is transported to urban drainage networks, workers are exposed to domestic sewage and are at risk of infection. And workers at sewage treatment plants are inevitably exposed to sewage during their work, or to viruses through air that evaporates into sewage treatment plants. When the sludge discharged from the sewage treatment plant is transported to the sludge treatment plant, the workers are exposed to the residual sediment of the sewage treatment. People who live near infected bodies of water or work in water that may carry the virus.(Giron-Navarro,Linares-Hernandez, Castillo-Suarez, 2021)

During rainfall, untreated sewage may be discharged into surface water. Susceptible sources of drinking water include surface water bodies, groundwater aquifers and rainwater harvesting systems. Transmission of the virus may include contamination of water sources and distribution of untreated water. And possible infectious exposure through oral administration of contaminated water or through washing with contaminated water. (Alahdal, H.M., Ameen, F. & AlYahya, S. et al. 2020.)

In a word, the daily production of sewage is unavoidable. If someone carries the virus into contact with sewage, this will put zheng at risk of spreading the virus throughout the sewage treatment and recycling process. Precipitation will accelerate the process of sewage into the water body, greatly increasing the risk of infection.

### 3.2 The impact of meteorological factors on the spread of COVID-19

Air pollution has a significant impact on human health and has been identified as the fifth major risk factor for death worldwide. Most of the burden of disease attributable to air pollution is caused by chronic non-communicable diseases, including respiratory diseases and diabetes. Studies have shown that long-term exposure to $PM_{2.5}$, $NO_2$, $O_3$ and NOx are associated with high risk of obesity and diabetes. The underlying mechanism of these associations is uncertain, but it is considered to be related to elevated levels of systemic inflammation, changes in adipose tissue metabolism, and imbalance of intestinal flora. (Manisalidis, Stavropoulou, Stavropoulos., & Bezirtzoglou, 2020.)

In the 2005 years since the SARS, studies have been conducted to investigate the relationship between air pollution in Beijing and the daily mortality rate of SARS patients. The correlation between the two has been proved, and the effect of air pollution on the prognosis of patients with infectious respiratory diseases has been warned. This study also provides a new understanding of the epidemic. (Rehman, A., Ashraf, F. & Javed, Z. 2022.)

Lin Pei, Xiaoxia Wang and others selected 325 cities containing at least one confirmed case of covid-19 as a study area in China on May 27, 2020. May 27 was used as the deadline for the study because the study was updated to May 27 in early June 2020 and the data set of covid-19 confirmed cases. The city is mainly distributed in the East and southeast of Chinese mainland. The figure 5 shows the research result of them.(Pei, Wang, Guo & Guo 2021.)

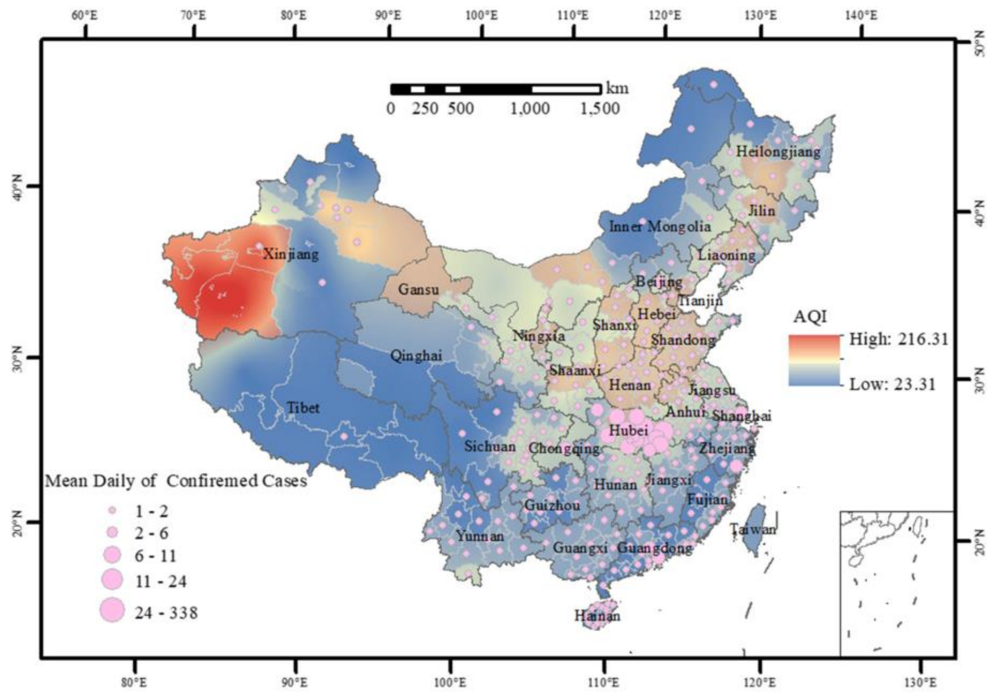


Figure 5. The spatial distribution map of mean daily COVID-19 confirmed incidences and AQI in the mainland of China from Dec 31, 2019, to May 27,2020 (Pei, Wang, Guo & Guo 2021.)

The study was chosen as a research period before closure, because during this period, people did not take protective measures extensively, and could not remove the mask when they were out to exclude the impact of the measures on the incidence rate of COVID-19. Air pollutant data include air quality index (AQI) and diameter of 2.5 μm particulate matter (P $M_{2.5}$), diameter 10 μm particulate matter ($PM_{10}$), sulfur dioxide ($SO_2$), carbon monoxide (CO), nitrogen dioxide ($NO_2$) and ozone ($O_3$). The data are from China National Environmental Monitoring Center. (Pei, Wang, Guo & Guo 2021.)

This research substitutes the data into the GWR Model to explore the relationship between air pollutants and epidemic spread. Because it consider the local effects of spatial objects, its advantage is higher accuracy.

| Study period | Data | Mean | SD | Min | Max |
|---|---|---|---|---|---|
| Before lockdown | Daily confirmed rate (per 100,000,0) | 0.73 | 1.52 | 0.04 | 8.71 |
| | PRE (mm) | 1.53 | 4.33 | 0.00 | 20.70 |
| | RH (%) | 8.00 | 1.33 | 3.80 | 10.00 |
| | TEM (°C) | 7.82 | 7.97 | −14.40 | 22.30 |
| | WS (m/s) | 1.86 | 1.48 | 0.40 | 13.00 |
| | AQI | 78.11 | 44.84 | 24.26 | 207.16 |
| | $O_3$ ($\mu g/m^3$) | 46.67 | 18.92 | 18.33 | 100.61 |
| | CO ($\mu g/m^3$) | 9.35 | 19.76 | 0.32 | 89.49 |
| | $NO_2$ ($\mu g/m^3$) | 34.91 | 15.83 | 5.89 | 76.46 |
| | $PM_{2.5}$ ($\mu g/m^3$) | 61.34 | 33.86 | 9.00 | 160.47 |
| | $PM_{10}$ ($\mu g/m^3$) | 69.27 | 39.95 | 22.28 | 213.63 |
| | $SO_2$ ($\mu g/m^3$) | 14.69 | 14.42 | 2.38 | 54.97 |
| Lockdown | Daily confirmed rate (per 100,000,0) | 3.33 | 26.67 | 0.03 | 1520.37 |
| | PRE (mm) | 2.26 | 6.69 | 0.00 | 80.00 |
| | RH (%) | 7.36 | 1.65 | 1.40 | 10.00 |
| | TEM (°C) | 5.33 | 8.51 | −24.5 | 22.7 |
| | WS (m/s) | 2.15 | 1.31 | 0.20 | 13.60 |
| | AQI | 58.02 | 39.51 | 10.92 | 390.17 |
| | $O_3$ ($\mu g/m^3$) | 52.85 | 18.98 | 4.79 | 123.34 |
| | CO ($\mu g/m^3$) | 15.60 | 19.84 | 0.19 | 113.02 |
| | $NO_2$ ($\mu g/m^3$) | 26.89 | 18.21 | 1.96 | 147.91 |
| | $PM_{2.5}$ ($\mu g/m^3$) | 50.80 | 36.80 | 0.00 | 480.63 |
| | $PM_{10}$ ($\mu g/m^3$) | 53.55 | 36.12 | 0.00 | 455.67 |
| | $SO_2$ ($\mu g/m^3$) | 23.39 | 19.80 | 1.96 | 170.47 |
| After lockdown | Daily confirmed rate (per 100,000,0) | 1.18 | 2.36 | 0.04 | 7.46 |
| | PRE (mm) | 2.40 | 6.92 | 0.00 | 41.40 |
| | RH (%) | 6.83 | 1.78 | 1.70 | 10.00 |
| | TEM (°C) | 14.47 | 5.02 | 5.7 | 27.8 |
| | WS (m/s) | 2.39 | 1.02 | 0.40 | 6.70 |
| | AQI | 59.61 | 36.92 | 16.96 | 280.21 |
| | $O_3$ ($\mu g/m^3$) | 76.55 | 21.91 | 25.12 | 154.67 |
| | CO ($\mu g/m^3$) | 1.05 | 4.33 | 0.38 | 53.67 |
| | $NO_2$ ($\mu g/m^3$) | 33.89 | 15.84 | 8.12 | 96.96 |
| | $PM_{2.5}$ ($\mu g/m^3$) | 37.35 | 33.40 | 4.17 | 275.88 |
| | $PM_{10}$ ($\mu g/m^3$) | 59.98 | 42.50 | 10.33 | 330.71 |
| | $SO_2$ ($\mu g/m^3$) | 9.20 | 5.58 | 2.71 | 52.11 |

TABLE 1 : China's COVID-19 daily diagnostic incidence rate (100 thousand per person, 0), meteorological indicators and air pollutants descriptive statistics during the study period (Pei, Wang, Guo & Guo 2021.)

Table 1 shows the daily covid - 19 diagnostic incidence rate (100 thousand per person), meteorological indicators and air pollutants statistics during the study period (including before blockade, after blockade and before blockade). Before the blockade, the daily average meteorological indexes such as pre, Rh, TEM and WS were 1.53 mm, 8.00%, 7.82 ℃ and 1.86 M / s respectively. Air pollutants AQI, $O_3$, c o, $NO_2$, $PM_{2.5}$. The daily average concentrations of $PM_{10}$ and $SO_2$ were 78.11 and 46.67 μg/$m^3$、9.35μg/$m^3$,34.91μg/$m^3$. 61.34 μg/$m^3$, 69.27μg/$m^3$, and 14.69 μg/m3, respectively. (Pei & Wang, 2021.)

During the lockdown period, the average daily meteorological determinates including PRE, RH, TEM, and WS were 2.26 mm, 7.36%, 5.33 °C, and 2.15 m/s, respectively. The daily mean concentrations of air pollutants concerning AQI, $O_3$, CO , $NO_2$, $PM_{2.5}$, P $M_{10}$, and $SO_2$ were 58.02, 52.85 μg/$m^3$, 15.60 μg/$m^3$, 26.89 μg/$m^3$, 50.80 μg/$m^3$, 53.55μg/$m^3$, and 23.39 μg/$m^3$, respectively . (Pei & Wang, 2021.)

After lockdown, the average daily meteorological determinates including PRE, RH, TEM, and WS were 2.40 mm, 6.83%, 14.47 °C, and 2.39 m/s, respectively. The daily mean concentrations of air pollutants concerning AQI, $O_3$, CO , $NO_2$, $PM_{2.5}$, $PM_{10}$, and $SO_2$ were 59.61, 76.55 μg/$m^3$, 1.05 μg/$m^3$, 33.89μg/$m^3$, 37.35 μg/$m^3$, 59.98 μg/$m^3$, and 9.20 μg/ $m^3$,  respectively. (Pei, Wang, 2021.)

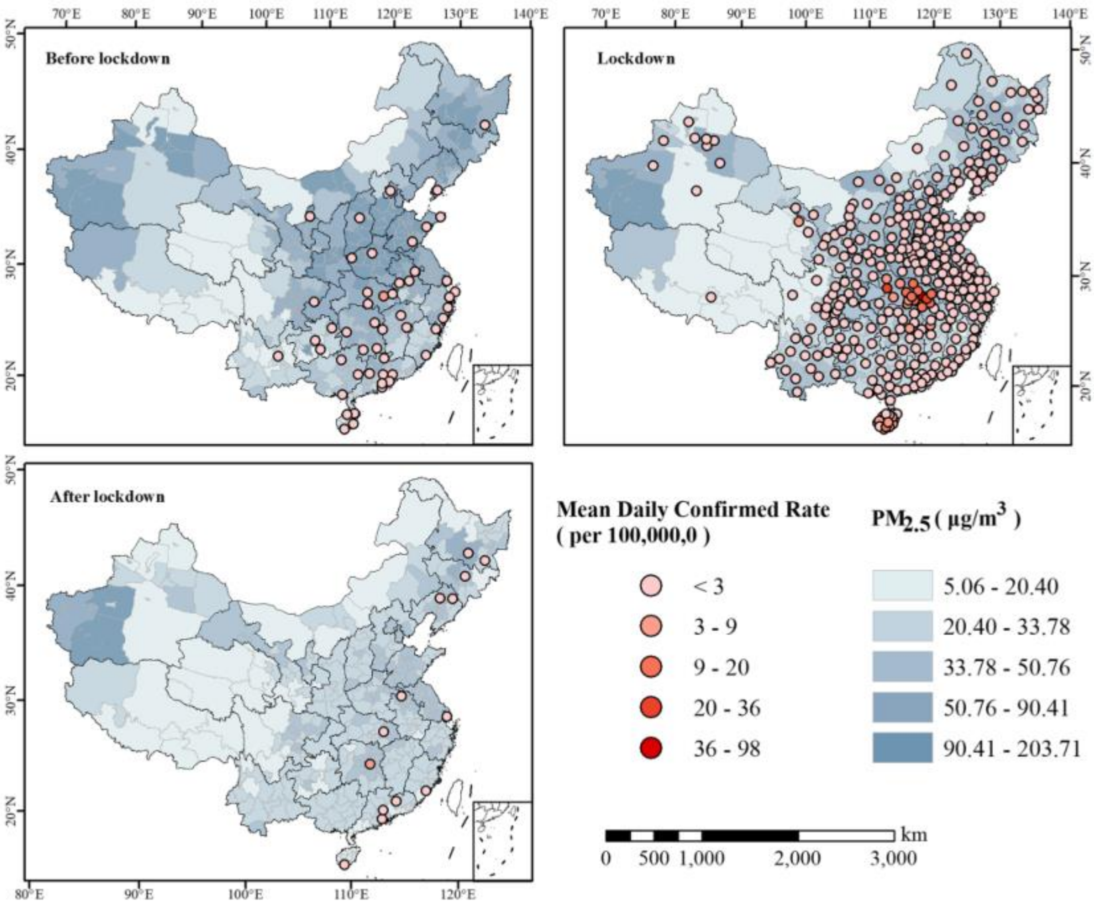


Figure 6. The novel coronavirus pneumonia rate and PM2. were diagnosed during the study period. 5 concentration distribution (Pei & Wang, 2021.)

As can be seen from Figure 6, there is significant spatial heterogeneity in the distribution of confirmed COVID-19 cases during the epidemic. The positive cases are concentrated in the eastern region. In addition, COVID-19 cases were concentrated in Hubei province during the lockdown. At the same time, in the process of epidemic spread, the concentration distribution of PM2 in China also shows strong regional differences, that is, the concentration in Southeast China is higher than that in Northwest China. In addition, the concentration of PM2 in central, northeast and northwest of China is higher than that in other regions. The distribution of New Coronavirus pneumonia, especially in the confirmed cases and PM2.5 In China, the concentration distribution is basically the same. The researchers compared confirmed COVID-19 cases with $PM_{2.5}$ concentration distributions. It was found that the distribution characteristics of the five concentrations were similar, which might be related to a series of measures taken by the local government, especially the blockade measures. Thus, it can be inferred that the similarity between the incidence of COVID-19 and the distribution of air pollution is not coincidental, but statistically significant. (Pei & Wang, 2021.)

### 3.3 The relationship between meteorological factors and the spread of COVID-19

In previous studies, meteorological factors have been proved to be one of the important variables affecting the spread of infectious diseases, especially respiratory infectious diseases such as influenza and SARS (severe acute respiratory syndrome). The spread of influenza usually increases in dry, cold winter and spring. The Chinese team collected COVID-19 cases and meteorological data from 224 cities. The incidence rate of incidence of temperature and relative humidity is not related to the cumulative incidence rate of city. Novel coronavirus pneumonia was diagnosed by China's 4 cities and 5 cities in Italy. The relationship between the number of confirmed cases and the 3 meteorological factors, including the highest temperature, the maximum wind speed and the maximum relative humidity, was observed. The results showed that the relationship between the maximum relative humidity and wind speed and the prevalence of covid-19 was not statistically significant. At present, the novel coronavirus pneumonia epidemic influence on meteorological factors is lacking of data support in a longer period and wider area, and the relevant epidemic prevention policy and medical resources are mixed. However, the existing research evidence and the current situation of the global epidemic show that the transmission of covid-19 cannot be effectively inhibited only by the rise of temperature. (Supari, S., Nuryanto, D.E., Setiawan & A.M. et al. 2021.)

## 4 DISCUSSION AND FUTURE PERSPECTIVES

From the end of 2019 to now, COVID-19 continues to affect people's normal life and greatly limit their work and production. However, with the decrease of human activities, the environmental environment is also obvious. However, the waste generated by the epidemic prevention materials spent by humans to fight the epidemic has a similar impact on the environment.

In an effort to contain the COVID-19 pandemic, many countries have imposed lockdown policies, bringing large-scale industrial production and civilian life to a halt. The strict lockdown regime has led to a dramatic drop in vehicle use, with air passenger numbers likely to fall by almost a quarter on average in 2020.

However, in order to contain the epidemic and the use of disinfectants, but caused a lot of harm to the environment, some experts pointed out that disinfectants can inhibit the virus, but if excessive disinfection is equal to "poisoning". Blind use of chlorine-containing disinfectant can not achieve the desired disinfection effect and may cause damage to human body. At the same time, it is easy to cause water, air and soil pollution. The use of a large number of disinfectants, harm aquatic organisms, and may even enter the water, so that microbial enrichment, and in the body of organisms continue to enrich, and then affect the food chain, ultimately harm human. At the same time, disinfectants will kill microorganisms in nature, destroy the balance of aquatic ecosystems, reduce the self-purification ability of water, and may lead to deterioration of water quality and accumulation of organic matter in the bottom mud. Combined with warm weather and other factors, there may even be black smelly water phenomenon.

The massive use of epidemic prevention materials has greatly increased the difficulty of medical waste transportation and disposal. Once medical waste is discharged into the environment without effective treatment, it will destroy the original ecology, kill the original microorganisms, volatilize toxic and harmful gases, and affect the air quality. The composition of acid, alkali and salt will also change the properties and structure of soil, leading to soil acidification, alkalization and hardening, and seriously damaging the ecological environment protection.

The environment and the spread of COVID-19 are influencing each other. The generation of domestic sewage is inevitable. Once the sewage that has been touched by or produced by patients with the virus enters the urban sewage treatment system, the risk of infection will be caused during the sewage treatment cycle. The risk of infection increases dramatically if the virus enters water bodies and is then transported through water purification plants to users' homes.

Novel coronavirus infections are respiratory infections transmitted mainly through air and water droplets. Pollutants in the air are good vectors for virus transmission. Comparing the distribution of air pollutants with the spread of outbreaks shows that the similar geographical distribution of COVID-19 incidence and air pollution is no coincidence.

## 5 CONCLUSION

A number of problems were exposed during the outbreak: the inability of humans to detect and respond to outbreaks first in order to contain their spread. Many areas lack the capacity to deal with large numbers of infectious disease patients. The generation of a large amount of medical waste is also one of the problems facing mankind. At present, the disinfection of public places is mostly limited to the indirect spraying of disinfection water on a large area. Of course, this is also conducive to epidemic prevention and control. However, a large amount of sterilized water causes environmental pollution that cannot even be remedied. The use of large amounts of disinfectants for COVID-19 poses huge risks to wildlife and the environment. (Manisalidis, Stavropoulou, Stavropoulos., & Bezirtzoglou, 2020.)

According to statistics, about 60% of infectious diseases are zoonoses, which are transmitted from animals to humans. In the past 30 years, 30 new human pathogens have been discovered, 75% of which are from animals. Other diseases associated with zoonoses include SARS, Ebola, Chaika, Nipah, avian influenza and swine flu. As human activities continue to affect ecosystems around the world, there may be more infectious diseases jumping from wild animals to humans in the future. With the loss of their natural habitat, wild animals are forced to move into human-dominated environments. Many species have adapted to this simple ecological environment, infecting humans and/or livestock with pathogens they carry. In complex, undisturbed ecosystems, pathogens are often "diluted," which can reduce the rate of contact between qualified hosts. Dilution diminishes and the risk of virus transmission increases.

COVID-19 is a disaster facing all mankind, causing great loss and suffering to people around the world. This paper discusses the relationship between the spread of COVID-19 and environmental factors, from which it can be seen that there is an inseparable relationship between the two. Therefore, protecting the environment means protecting human health and life. The problems exposed by the epidemic also remind us that it is extremely urgent to strengthen sewage treatment, medical waste treatment and people's awareness of environmental protection and epidemic prevention.

At first, no one cared about the disaster, it was just a flu, until it touched everyone. To protect nature, to Revere nature, to be grateful to nature, and to seek a balance between man and nature should be the code of conduct that human beings should follow at all times. In the wake of the epidemic, people around the world will have a deeper understanding of this vision, a richer interpretation of it, and a deeper understanding of what a community with a shared future for mankind means. Caring for the earth and seeking harmonious coexistence between man and nature requires the joint efforts of every citizen of the earth. The epidemic will eventually pass, but cherishing the earth and protecting nature should be the long-term task of every human being.

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