Journal of Climatology and Weather Forecasting 2022, Vol. 10, Issue 11, 001-007 Research Article

Environmental Impacts of Coronavirus Disease (Covid-19)

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Received: 21-Nov-2022, Manuscript No. JCWF-22-20284, **Editor assigned:** 22-Nov-2022, Pre-QC No. JCWF-22-20284 (PQ); **Reviewed:** 23-Nov-2022, QC No. JCWF-22- 20284(Q); **Revised:** 23- Nov-2022, Manuscript No. JCWF-22-20284 (R); **Published:** 28-Nov-2022, DOI: 10.35248/2332-2594.22.10(11).375

Abstract

COVID-19 is a universal fret. The study attempts to scrutinize the salient environmental impacts of the pandemic on climate, water supply and effects on animals which have not been conspicuous. While global data on mean surface temperature was generated from Copernicus Climate Change Service/ ECMWF for the period 2019 and 2020, desk survey on the survival rates of coronaviruses in effluents and case studies on animal susceptibility was revealing. A drop in temperature due to decreased greenhouse gas emissions during the lockdown for CO_2 and NO_2 was evident. For example, average CO_2 emissions dropped from 50 g/kWh to 12 g/kWh during the March to April 2020 period. Case reviews on animals susceptible to the virus revealed the leading number of events in the U.S, China and Belgium. The study situated the policy implications with elaborate recommendations on prompt environmental monitoring and awareness necessary to realize the ecological sustainability of future concerns.

Keywords: COVID-19 pandemic • Environmental impacts • Air quality • Wastewater • Emissions

Introduction

Coronaviruses belong to the family *Coronaviridae* under the order *Nidovirales* [1]. The virus is named as coronavirus due to the present of crown-like spikes on its outer surface [2]. Recently the world population has been suffering from Coronavirus Disease 2019 (COVID-19), an acute respiratory illness that can be transmitted through personal contact and respiratory droplets. The COVID-19 is a disease triggered by Austere Acute Respiratory Syndrome Coronavirus 2 (AARS-CoV-2). It originated from Wuhan (WHO, 2020) [3], Hubei's provincial capital city in China's Central region [4].

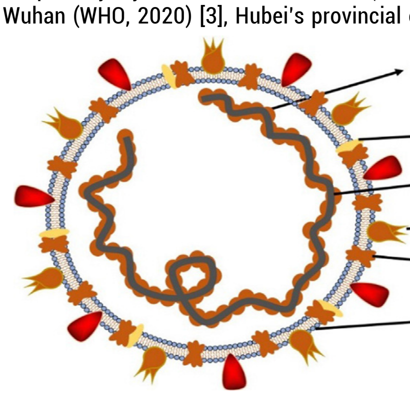

Figure 1. Typical structure of a human coronavirus.

Wuhan is spanning 8,494 km^2, located on the Yangtze River, about 800 Km west of Shanghai and one of the most populated cities (over 11 million people) in the country [5]. The International Committee on Taxonomy of Viruses (ICTV) named the virus as SARS-CoV-2 and the disease as COVID-19 [6,7]. The SARS-CoV-2 is a single-stranded positive enveloped RNA virus whose genome length extends up to 30 kilobases (Figure 1) [8].

The first attempt on Coronavirus isolation was in birds in 1937 [9]. Human coronaviruses responsible for respiratory illness was first identified in the 1960s[10]. Currently, there are seven types of coronaviruses responsible for human infection. These are 229E, NL63, OC43, HKU1, SARS-CoV[11], MERS-CoV and recent SARS-CoV-2 [12-14]. The first case was confirmed in Hubei in November 2019. From then it spread to other countries like the United States (886,709) cases, Spain (213,024) cases, Italy (189,973) cases, France (158,183) cases, Germany (153,129) cases as of 24th April 2020 and many other parts of the world including Africa which confirmed its first case on February 14th 2020 [15, 16]. The COVID-19 was confirmed a Public Health Emergency of International Concern by the World Health Organization (WHO) on 30th January 2020 and renowned it as a pandemic on 11th of March 2020 [17,18].

The COVID-19 pandemic is said to have originated from a Wuhan seafood market where illegal trade of wild animals, e.g. marmots, birds, rabbits, bats and snakes, is done. Because the virus is known to have jumped from animal to a man, it is thought that the first infected groups of the COVID pandemic are those stallholders from the market which they contacted from the animals. Even though the COVID-19 animal source is still a mystery, the Wuhan institute for virology team did a study showing the genetic makeup of the pandemic virus to be 96% identical to that of a bat. Another study which was done in March on Pangolins showed that their genetic makeups are between 88.5%-92.4% which is similar to that of the human virus [19]. Other cases of COVID 19 appear to be pre-dated and without any link to the Chinese-Wuhan market which is quite inflicting. The market was shut down for thorough cleaning, disinfection and inspection in early 2020 but it appeared that the virus had already spread beyond the market to other towns [20].

The COVID-19 family of virus causes illnesses such as common cold, Severe Acute Respiratory Syndrome (SARS) and the Middle East Respiratory Syndrome (MERS) [17]. Its signs and symptoms are fever, shortness of breath, cough, sore throat, headache among others and may appear in two days to fourteen days after exposure and some may go without the symptoms at all [16]. The Virus is a huge, envelope-shaped, positive-stranded RNA and can be grouped into four genera: Alpha, Beta, Delta and Gamma. Out of these four generas, the Alpha and Beta are known to infect humans [21].There are shred of evidence that the COVID 19 is spread from human to human with the significant transmission route being through close contact and droplets [22].

At least 20%-30% of the COVID-19 patients in most countries required ventilation and out of them, 10% died. The high mortality rate is found with the aged people and those already infected with different diseases [23]. High transmission is found in congregation places such as supermarkets, hospitals, schools and high learning institutions, churches and mosques, wedding gatherings and burials. This brought about movement restrictions, Late hour Curfews, Partial and total lockdowns in most of the countries affected with the COVID-19 disease. Measures such as one-meter distance rule, wearing of masks, hand washing, isolation of infected persons, and the use of sanitizers were sensitized in all media platforms and some were reached out in the village in creating awareness. These measures were in a bid to flatten the COVID mortality curve in most countries.

Dynamics of COVID-19 pandemic

Zhao and Chen identified the distinctive characteristics of Covid-19 virus to include its high infectivity during incubation, time delay between real dynamics, daily observed number of confirmed cases a nd the intervention effects of implemented quarantined and control measures [24,25]. The spatial dynamics of Covid-19 has been reported successful in different countries with high risk such as China and its spread reveals options for its effective prevention control [26,27]. The spread is possible due to several factors viz; population density and size, migration and traffic flow, host immunity, medical care quality, climate conditions (temperature and humidity), and proximity to major entry points [28, 29]. Case examples reveal that through population density clusters, the transmission of the virus by the human to human through respiratory droplets from sneezing, coughing and aerosols from symptomatic patients have been situated empirically [30,31]. Spatial dependency has also made it possible for the spread across urban provinces in Wuhan and Nigeria through transportation [32,33].

The persistence of Covid-19 extends to its capacity to remain infectious on inanimate surfaces for up to 9 days [34]. Evidence reveals that patients can contract the virus from certain abiotic infected surfaces[35,36]. The environmental factors of climate (temperature and humidity) and its role in spreading the pandemic have been duly considered. Mecanas, et al, (2020) attempted a correlation of the pandemic with temperature and relative humidity [37]. In similar studies such as the place of hot temperatures and humid climates have been evaluated as a key factor in the spread of the pandemic [32, 38-40].

Modelling of the dynamics of the pandemic has been rife. These models have been applied to predict and control the future profile of the virus spread. It has served as a tool for quantifying parameters of variables on the effects of quarantine, confirmation of infected patients, and the efficacy of containment measures. Spatial explicit models have stood to mediate between the future policing efficiency and its spread [41,42].The stochastic transmission model has been utilized to reveal the efficacy of travel restrictions in China, likewise the efficacy of human to human transmission. This has been successful using a model structure consisting of Susceptible, Exposed, Infectious, and Removed [43]. The researchers submitted that some proportions of exposed individuals migrate and their similar infectious character detected in their respective destinations.

Similarly, Zhao and Chao developed a model-SUQC (Susceptible, Un-quarantined Infected, Quarantined Infected, and Confirmed Infected) framework to interpret the dynamics of Covid-19 concerning the intervention effects of different control measures in China [44]. In Italy, the SEPIA (Susceptible, Exposed, Pre-symptomatic, infected with heavy symptoms and Asymptomatic) model was been adopted. This SEPIA model was extended in the study to incorporate the HQRD variables (Hospitalized, quarantined at home, Recovered, and Dead). As different containment measures have reduced the transmission by 45% [45]. Presymptomatic transmission appears critical in increasing the spread within a neighbourhood. Case examples include; 12.6% reports in China, 48% in Singapore, and 62% in Tianjin, China [46-48].

These transmission variables modelled, favour the sense of intuition into the contagiousness of the pandemic and ascertain the efficacy of both individual and community control measures to the eradication of the outbreak and as well guide the implementation of alternative innovations [49-52].

Increased risks and infections of Covid-19 across the world have heightened the global concern for the most efficient control measures for its eradication. The control and mitigation efforts are regnant from the individual level to community and mobility restrictions [53]. These recommendations are rife on efficient preventive clearing and eradication of the novel pandemic. They include; diagnosis with nuclei acid kit, interrupting transmission from animal to humans, interruption of transmission of all sources, adequate isolation and treatment, prompt care for patients, early protection, and improved hygiene [54-56]. Aside the regular personal intervention such as strict compliance and advocacy on frequent hand washing, use of alcohol-based sanitizers, staying at home, use of nose masks, and regular sanitation [57]. Community adaptation and interventions are helpful. Interventions in business closure, institutional dismal, adoption of ICT virtual packages, cancellation of all events and practical social distancing has curtailed the spread of the virus in the different scenarios [33].

In appraising the trend and dynamics of Covid-19 pandemic, it is suggested that many variables must be factored in the modelling of the future realities to include policies of containment, social distancing, isolation and quarantine, restrictions on high population density in cities, lockdown and movement, travels, increasing health care system, patient's conditions are sensitive to combat the novel Covid-19 pandemic.

Many studies have been done from the month of December 2019 till date concerning the COVID 19 pandemic. However, the impact of this disease on the environment has hardly been researched on considering the behaviour of certain environmental parameters to improve the risk communication needs across the world. This paper therefore, is poised to bridge the gap and give out quality information of the disease impact on the environment and the likelihood of its control. On a general note, its purpose is primarily to review the disease impact on climate change, greenhouse gas emissions, air pollution, hazardous and waste bodies, water resources and its effect on beneficial bacteria within the period the peak periods of the global penury.

Material and Methods

Data collection

The study examined through review the environmental aspects of Covid-19 pandemic with the use of the survey approach. This approach targeted explicit/ discreet data on the significance of Covid-19 on air quality and climate, water resources and supply and the effects on animal. Global data on greenhouse gas emissions of the world were pooled from the Copernicus Climate Change Service / ECMWF for the periods 2019 to 2020. CO_2 and NO_2 trend was also assessed through the database of RTE (Reseau de Transport d'Electricite). Desk surveys were used to assess the environmental perspectives of Covid-19 pandemic as it relates to the effect on water resources and supply and animals (biodiversity).

Results

COVID-19 on climate change

In this study, the Impact of COVID-19 and the lockdown in a sequence was investigated around the globe and particularly in Europe where it became the epicenter of pandemic [58]. Data on Copernicus Climate Change Service/ECMWF was shown in Figure 2 [59]. There it shows the global mean surface air temperature anomalies (°C) relative to 1981-2010 from February to April 2020 against the same period in 2019. The trend in 2019 indicated that from February there is a rise in temperature, however in 2020 the temperature reduced due to the pandemic.

The European-mean temperature due to strict restriction in the pandemic period has a magnificent fall in temperature as it is presented in Figure 3 with decreasing Greenhouse Gas (GHG) emission units such as CO_2 and NO_2, even though it is still almost 2°C above the average temperature of 1981-2010 [60].

Global Energy Review 2020 reports stated that energy demands at its first quarter of 2020 depending on the types of lockdown (restriction limitation, partially and fully lockdown) have decreased 3.8% relative to its stance in 2019, these demands include oil, gas and electricity [61]. The climate change issues in a short time cannot be solved and need a more practical plan to implement, however during the pandemic lockdown the CO_2 emission has fallen sharply, for instance, in France as one of the top 5 infected countries, the CO_2 emission reduced from 50 g/kWh to 12 g/kWh during the March-April period, the Figure 4 indicates the trend of CO_2 emission in March and April 2020 based on the data of RTE (Réseau de Transport d'Électricité) [62]. The data of each day has been interpolated

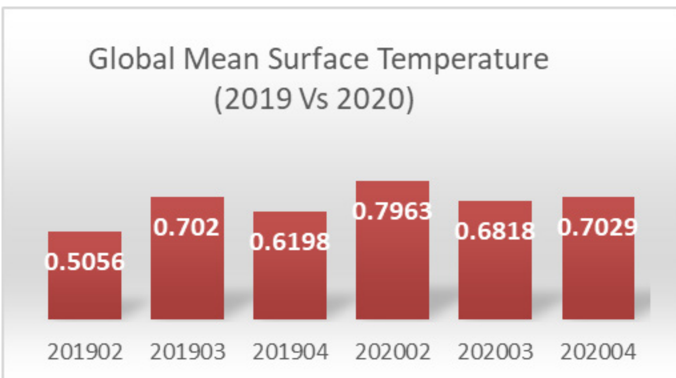

Figure 2. Global-Mean Surface Temperature (2019 vs 2020).

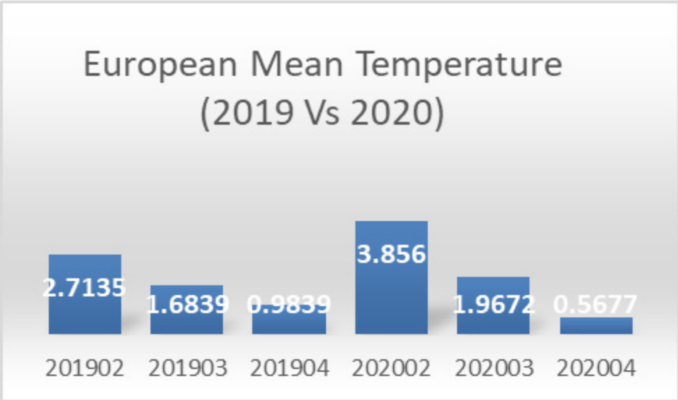

Figure 3. European Mean Temperature (2019 vs 2020).

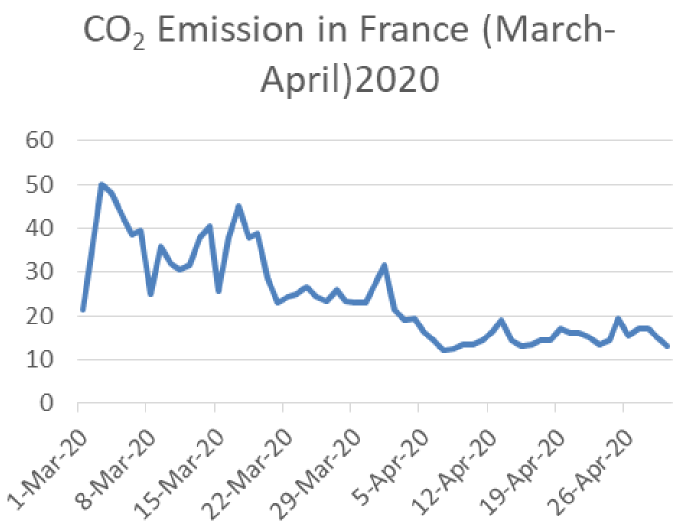

Figure 4. CO_2 emission in France (March-April) 2020.

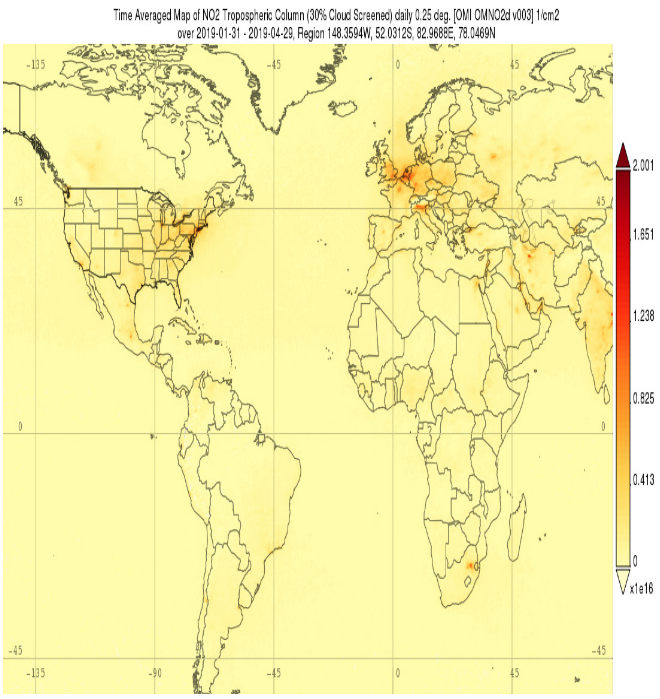

Figure 5. NO_2 Emission for February to April 2019.

based on the maximum and minimum of emission amount.

The other GHG i.e. NO_2, based on NASA Earth Data, the pandemic and the lockdown affected the amount of NO_2 emission compared to the same period in 2019, as it is shown in Figure 5, NO_2 emission significantly reduced globally and mainly through Europe in 2020 compared to 2019 [50].

Water resources and supply

In water body, the inactivation rate of the virus may accelerate in the presence of predacious microorganisms i.e. protozoa [63]. Again, the death rate of coronaviruses increases very rapidly in wastewater including 99.9% destruction in 2 days–3 days [64], whereas survivability of the coronaviruses found much longer in primary wastewater than secondary wastewater [65].

Evidence of the existence of the COVID-19 virus has not been found in drinking-water or sewage [66]. The risk of surrogate coronaviruses to water supplies was reported very low from the previous experiments [67]. In contrast, coronaviruses have remained infectious in filthy water containing faeces for several days in the confined laboratory studies [68]. About 2%-10% of the total confirmed COVID-19 patients were associated with diarrhea (4-6) and two studies identified COVID-19 viral RNA fragments in their excreta [69]. Though one research has cultured the COVID-19 virus from stool specimen [70]. No reports claimed about the fecal-oral transmission of the COVID-19 virus [71].

Typically, enveloped viruses including the COVID-19 virus are more vulnerable to oxidants such as chlorine thus are less durable to nature (Table 1). One study found that human coronavirus was alive only two days in de-chlorinated tap water and hospital wastewater at 20°C [72]. In contrast, transmissible gastroenteritis coronavirus and mouse hepatitis virus were found died at a rate of 99.9% from 2 days at 23°C to 2 weeks at 25°C [73,74]. Sustainability of survival of human coronaviruses on surfaces varies from 2 hours to 9 days depending on various factors including surface type, temperature, relative humidity and virus strain [75].

To safeguard water from contamination with the virus, the safety of water from the source to utilization should be ensured. Common water treatment methods including filtration and disinfection, would inactivate the COVID-19 virus since other human coronaviruses have been found sensitive to chlorination and disinfection with Ultraviolet (UV) light [76].

Survival and decrease of titre rates of the coronaviruses measured in days from different water sources. The rates were measured at different temperatures from filtered and unfiltered tap water and primary effluent and secondary effluent. The rates much depend on temperature, organic matter and aerobic microorganisms [77].

Survival rates of coronaviruses in both primary and secondary effluent were less than two days being significantly less than that of those in tap water which ranged from six to more than a hundred days. Fewer days were recorded when the temperature was high that is at room temperature (23°C), at 4°C the highest number of days were recorded being more than 100 for the survival rate and more than 200 for the rate of decrease of titre. In filtered tap water, the viruses survived for approximately six days which was less than the rate in unfiltered tap water which accumulated to eight days [77]. At room temperature, the virus survived for lesser days than at 4°C in filtered water. At room temperature, the highest survival rate was recorded in unfiltered primary tap water being two days while in filtered primary effluent and secondary effluent, the survival rate was one day. The highest rate of decrease of the virus titre was two and three days recorded at room temperature in filtered primary effluent and secondary effluent and unfiltered primary effluent respectively. It would take approximately more than 200 days for the titre to decrease in filtered tap water at 4°C [78]. At room temperature, it took 10 days and 12 days for the virus titre to decrease in filtered and unfiltered tap water, respectively.

Coronaviruses survive less and quickly decrease titre at room temperature in secondary and filtered primary effluent [40]. At room temperature, the viruses' highest survival and decrease in titre rate were recorded in unfiltered tap water being eight and 12 days, respectively [39]. In overall, the highest rates were recorded at 4°C giving approximately more than 100 days for their survival rate and more than 200 days for the rate of decrease of titre [39].

Effects on animals

Coronavirus infections are found in both humans and animals [79]. There are strains of coronaviruses which have been proven to be zoonotic, meaning that transmission can be between animals and humans [80]. However, many strains of this virus are not zoonotic [79]. Below in Table 2 is a list of animals which tested positive for coronavirus SARS-CoV-2.

One cat (*Felis Catus*) in Belgium tested positive for SARS-CoV-2 using high throughput sequencing method. In Hong Kong China virus isolation was used to confirm the positive case in a dog (*Canis l upus*). Five tigers (*Panthera tigris*), three lions (*Panthera leo*) and two cats (*Felis catus*) in New York tested positive after Gene sequencing and Real-Time Reverse Transcriptase Polymerase Chain Reaction (RRT-PCR). Of all these animals, there was no death recorded giving a 0% mortality rate. Summarised from [79]. A total of 12 animals tested positive of SARS-CoV-2 using a range of different effective diagnostic molecular methods. The animals included; *Felis Catus* (cats), *Canis lupus* (dogs) *Panthera tigris* (tigers) *Panthera leo* (lions). Highest confirmed cases were from tigers which were five. The least number of cases were in cats and dogs which were one for each animal. Average animals were 3 lions. The most significant number of cases was recorded in the United States of America, followed by China and Belgium. Gene sequencing and Real-Time Reverse Transcriptase PCR were the confirmatory tests used. All animals with confirmed cases of COVID-19 survived the disease and there is no evidence that the animals are infective to humans, however, there is transmission among them. Domestic animals were infected by their owner's will those from the zoo were infected by workers.

Discussion

There is a temperature drop as a result of the decline in the levels of Greenhouse gases such as CO_2 and NO_2 during the lockdown period based on the available data (Figures 4 and Figure 5). This resultant value in emission reduction has implications on improving global air quality thereby indicating the efficacy of lockdown policies in lowering emission levels. In water resource and supply, there are interactions and concerns of COVID-19 pandemic. The survival and decrease in titre values of coronaviruses are dependent on three main factors which are temperature, organic microorganisms and organic matter [77]. The least days are recorded in secondary effluent because the temperature was high enough to denature the virus and also inactivate some proteins it needs for survival [78]. Secondary effluent is rich in disinfectants like chlorine which are used in the purification of the waste. These chemicals have a great impact on the survival of viruses hence quickly decreasing their titre. In areas where temperatures exceed room temperature, this implies that coronaviruses can barely survive in these water sources if all factors are coupled.

In filtered primary effluent at room temperature, the rates were lower than in unfiltered primary effluent. These results can be owed to the fact that the filtered effluent did not contain solid particles which the virus could adsorb to and be encompassed hence surviving the effect of chemicals and microorganisms [79]. These particles can be removed by filtering thus explaining lower days in filtered primary effluent. Coronaviruses are enveloped and that gives them lesser chances of survival [80]. Generally, rates were lower in effluents because of chemicals involved, the organic matter and other microorganisms. Microorganisms like protozoa which are present may aid in reducing the virus titres [78]. Treatment of water, therefore, is of paramount importance even though this may harm other beneficial microorganisms. Conclusively, the presence of coronaviruses in these water sources cannot be a great cause of concern if all proper procedures of water treatment are followed. Scientifically, the viruses present are not a viable community hence they cause no infections [81]. Epidemiologically, wastewater is not a transmission route.

Table 1. Coronaviruses' survival and decrease of titre rates at different temperatures in different water sources.

Water Source	Temperature ^{0}C	Survival rate	Decrease of titre
Filtered tap water	23	6	10
Unfiltered tap water	23	8	12
Filtered tap water	4	>100	>200
Filtered primary effluent	23	1	2
Unfiltered primary effluent	23	2	3
Secondary effluent	23	1	2

At room temperature, filtered tap water had lower days than unfiltered tap since filtering reduced the influence of organic matter on the viruses. Temperature also impeded the increase of the rates. Tap water is treated and tested before allowed to flow to households and the treatment counteracts survival of viruses [82]. Challenges may be faced in developing countries where chemicals are in short supply and water is not safe for consumption hence boiling it would kill the virus. At 4°C days of survival and decrease in titre increased exponentially to very high numbers proving that the virus depends on temperature for its survival [77]. Lower temperatures are the optimum temperature for the virus to thrive.

Other negative impacts of coronavirus are the losses incurred in the oil, shipping, recreation and tourism business as many countries along the globe went on lockdowns [78]. On the brighter side, this implied that there was no shipping therefore, clearing coasts. The clearance of coasts reduced pollution of water sources by oils and gases emitted by ships for example, nitrogen dioxide. In China, nitrogen dioxide pollution significantly decreased during the first few months of 2020 after the lockdown [78]. This was shown by satellite images from the European Space Agency and NASA.

COVID-19 has been confirmed to be a zoonotic disease implying that it can be transmitted from humans to animals [82]. However, there is no evidence that animals can infect humans but rather one of their own. Two dogs from the same household were isolated on 18 March 2020 following the hospitalization of their owner due to COVID-19 infection. On the 19th of March, one of the dogs tested positive for the virus in New York, USA [79]. These animals were not exhibiting any precise clinical signs. On the 18th of March 2020, the Veterinary Medicine Faculty of a University in Belgium reported that viral RNA of the SARS-CoV-2 virus had been identified in vomits and stools of a cat hence exhibiting clinical signs of the respiratory infection [79]. A person who had confirmed positive for SARS-CoV-2 owned the animal. Viral RNA strands in the cat were confirmed using high throughput sequencing [79]. Suspicions that the infection was productive have not yet been confirmed. In such times animals should be isolated from humans. Two cats from different households showed clinical signs including sneezing and ocular discharge for the respiratory disease in China. Samples from the cats were tested using PCR for the viral RNA, SARS-CoV-2, after testing negative for other respiratory infections. One cat was owned by a COVID-19 affected person, the other from a household in an affected neighbourhood and allowed to go outdoors. Both cats tested positive for SARS-CoV-2. Both cats were clearing the infection thus recovering. From the information of these animals which were domesticated, it shows that the disease is zoonotic, therefore, when a pet owner has symptoms it is important to isolate animals as well [79]. Though not yet proven that animals may infect humans, there is a chance that it may happen since the first cases were related to a seafood market. Therefore, precautions must be taken.

According to the results, five tigers and three lions in a zoo in New York exhibited signs of COVID-19. On the 27th of March, the first tiger showed clinical signs of disease [79]. A week later, the number of symptomatic animals accumulated due to the incubation period. Zoo animals are missing attention from people since they have to be quarantined as well to avoid transmission of the virus to the animals [83]. This is endangering our wildlife. Clinical signs included dry cough, wheezing and lack of appetite but none with respiratory distress. The animals were quarantined and did not infect other animals. Quarantine is one of the most effective measures to stop the spread of the virus since there is no vaccine as yet [82]. Samples collected confirmed positive for the SARS-CoV-2 PCR test. There was no death hence, mortality rate was zero and all animals were stable. This shows that quarantine and disinfection were useful to stop the disease.

Quarantine and disinfection help to treat infected animals [80]. These methods have proved to work as there were no deaths recorded from infected animals. Or does this mean that these animals are hosts? Animals may spread the disease among themselves as they are walking free in

Table 2. Animals Susceptible to SARS-CoV-2 in different countries and tests used for confirmation for the positive cases.

The Onset of an outbreak	Country/City	Animal	Test	Susceptible	Mortality
18/03/2020	Belgium	Felis catus	Throughput sequencing	1	-
20/03/2020	China - Hong kong	Canis lupus	Virus isolation	1	-
27/03/2020	USA - New York	Panthera tigris	Gene sequencing, RRT-PCR	5	-
27/03/2020	USA - New York	Panthera leo	Gene sequencing, RRT-PCR	3	-
27/03/2020	USA - New York	Felis catus	Gene sequencing, RRT-PCR	2	-

streets of some countries due to the lockdown [82]. The New York-based Wildlife Conservation Society is commending authorities to prohibit live animal markets, and illegitimate trafficking and rustling of wild animals hence a negative impact on global wildlife trade [79]. CDC is operating with human and animal health personnel to monitor this condition and will provide updates continually as information becomes accessible. Further studies and research are needed to appreciate if and how different animals could be affected by COVID-19. Initial findings from the research suggest that pigs and poultry are not susceptible to SARS-CoV-2 infection [79].

Policy implications for environment management sustainability and communication

There is nexus between the reality of Covid-19 pandemic and the challenges in the realization of Sustainable Development Goals (SDG). The pandemic and the lockdown policies have peculiar inclinations with these goals and thus the need for a drastic solution remains imperative. For instance, SDG such as Goal 1: No poverty; Goal 2: Zero hunger; Goal 3: Good health and wellbeing; Goal 4: Quality education; Goal 6: Clean water and sanitation; Goal 8: Decent work and economic growth; Goal 11: Sustainable cities and communities and others would not be fully realized where the pandemic prevail. The cure and eradication of this pandemic have ties with the achievement of these environmental management and sustainability objectives as follows:

- Preventive measure is the sole way to keep disinfect from the COVID-19 virus. Therefore, the practice of regular and proper hygiene is essential for virus containment.
- Apply WHO guidelines on responsible management of drinking water and sanitation services. Disinfection will be helpful to destroy many harmful pathogens including the COVID-19 virus.
- For climate action, the emission reduction of greenhouse gases has unraveled the impacts of the pandemic on the air environment and the implications of global emission reduction in the global fight for climate change mitigation.
- Regular cleaning of sinks using bleaching powder or alcohol-based cleaner as the virus has proven to persist on inanimate surfaces.
- Control run-off water from medical institutions and research laboratories and effective water treatment before discharging to any receiving environment.
- Environmental surfaces should be cleaned regularly and accurately before they are reused since COVID-19 virus can prevail in the environment some days.
- Dry cleaning of laundry items such as bedsheets, towels, tea towels, cushion covers and other fabrics should be done during coronavirus pandemic.

Conclusion

There are cogent environmental impacts of COVID-19 pandemic on air quality, water resources/ supply and effects on animals (biodiversity). Based on these findings, the research strongly supports the regular environmental monitoring of all media and datasets to improve the decision-making process in the environmental sustainability goals of the world by prompt awareness and risk communication. Future studies could assess the impacts of COVID-19 on biodiversity and effects on aquatic pathogenesis, including the environmental implications of disposal of nose masks and hospital wastes from infected patients. These are emerging environmental problems which must be addressed for the safety of the environment and humans. As the world strives for a cure of the pandemic, efforts must be made to eradicate all potential environmental impacts of the pandemic to enable the attainment of the global sustainable goals.

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Cite this article: Anukwonke, C.C, et al. Environmental Impacts of Coronavirus Disease (Covid-19). *J Climatol Weather Forecast*, 2022, 10(11), 001-007.