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Indirect effects of COVID-19 on the environment

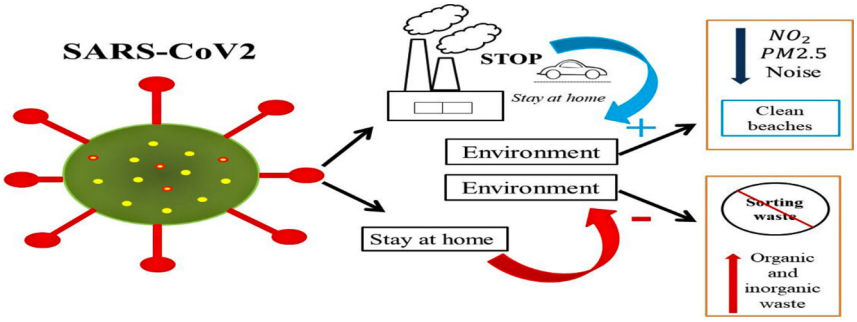
Manuel A. Zambrano-Monserrate [a,*], María Alejandra Ruano [b], Luis Sanchez-Alcalde [c]

[a] Universidad Espíritu Santo, Ecuador
[b] Escuela Superior Politécnica del Litoral, ESPOL, Facultad de Ciencias Sociales y Humanísticas, Campus Gustavo Galindo Km 30.5 Vía Perimetral, P.O. Box 09-01-5863, Guayaquil, Ecuador
[c] Universidad Autónoma Metropolitana, Iztapalapa, Mexico

HIGHLIGHTS

- Positive and negative indirect effects of COVID-19 on the environment are presented.
- Contingency policies are linked to improvements in air quality, clean beaches and less environmental noise.
- Increased waste and the reduction of recycling are negative side effects of COVID-19.
- Decreasing GHGs during a short period is not a sustainable way to clean up our environment.

GRAPHICAL ABSTRACT



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ABSTRACT

This research aims to show the positive and negative indirect effects of COVID-19 on the environment, particularly in the most affected countries such as China, USA, Italy, and Spain. Our research shows that there is a significant association between contingency measures and improvement in air quality, clean beaches and environmental noise reduction. On the other hand, there are also negative secondary aspects such as the reduction in recycling and the increase in waste, further endangering the contamination of physical spaces (water and land), in addition to air. Global economic activity is expected to return in the coming months in most countries (even if slowly), so decreasing GHG concentrations during a short period is not a sustainable way to clean up our environment.

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1. Introduction

The new coronavirus (SARS-CoV2) has generated an unprecedented impact in most countries of the world. The virus has affected almost every country on the planet (213 in total), spread to more than 2 million people, and caused around 130,000 deaths (WHO, 2020a).

Currently, most countries have tried to fight the spread of the virus with massive COVID-19 screening tests and establishing public policies of social distancing. It is clear that the priority revolves around people's health.

For this reason, the indirect impact of the virus on the environment has been little analyzed. The first studies estimated a positive indirect impact on the environment. On the one hand, climate experts predict that greenhouse gas (GHG) emissions could drop to proportions never before seen since World War II (*Global Carbon Project*, 2020). This outcome is mainly due to the social distancing policies adopted by the governments following the appearance of the pandemic.

For example, in Hubei province (China), strong social distancing measures were implemented in late 2019. These measures affected

* Corresponding author.
E-mail address: manuelzambranom@uees.edu.ec (M.A. Zambrano-Monserrate).

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the country's main economic activities. As a result, power plants and industrial facilities halted their production. Also, the use of vehicles decreased considerably. All this led to a dramatic reduction in the concentrations of Nitrogen Dioxide (NO_2) and Particulate Matter that have a diameter of less than 2.5 μm (PM 2.5) in the main Chinese cities (ESA, 2020a; CAMS, 2020, Fig. 1).

In other parts of the world, such as Europe, air pollution has dramatically reduced since governments ordered citizens to stay at home to contain the spread of the new coronavirus. Main industries as well as other regular activities have ground to a halt. For instance, car use has reduced which caused GHGs to decrease. Fig. 2 clearly illustrates a sharp reduction in NO_2 concentrations in countries such as France, Germany, Italy, and Spain (ESA, 2020b).

Also, the social distancing measures adopted by most governments have caused many beaches around the world to get cleaned up. This as a result of the reduction in waste generated by tourists who visit the beaches. Likewise, noise levels have fallen significantly in most countries. The decrease in the use of private and public transportation, as well as commercial activities, has caused a reduction in noise.

Despite the positive indirect effects on the environment, the new coronavirus has also generated negative indirect ones. For example, in the USA, some cities have suspended recycling programs because authorities have been concerned about the risk of spreading the virus in recycling centers. On the other hand, in the European nations particularly affected, sustainable waste management has been restricted. For example, Italy has prohibited infected residents from sorting their waste.

On the other hand, some industries have seized the opportunity to repeal disposable bag bans. Companies that once encouraged consumers to bring their bags have increasingly switched to single-use packaging. For example, a popular coffee company announced a temporary ban on the use of reusable cups. Finally, online food ordering has increased. These growths are resulting in the increase of domestic waste, both organic and inorganic.

This research aims to show the positive and negative indirect effects of the SARS-CoV2 coronavirus on the environment. After analyzing each indirect effect, objective conclusions on the subject are presented.

2. Positive and negative indirect effects of COVID-19 on the environment

2.1. Decreased concentrations of NO_2 and PM 2.5

Air quality is essential for people's health; however, 91% of the world population lives in places where poor air quality exceeds the permissible limits (WHO, 2016). The consequences of air quality degradation are manifested in a significant percentage of global mortality each year (Zhang et al., 2017). In this regard, the 2016 World Health Organization (WHO) report indicates that air pollution contributes to almost 8% of total deaths in the world; the most affected countries being those found in Africa, Asia and part of Europe (WHO, 2016).

China implemented strict traffic restrictions and self-quarantine measures to control the expansion of SARS-CoV2. These actions generated changes in air pollution. Due to quarantine, NO_2 was reduced by 22.8 μg/m^3 and 12.9 μg/m^3 in Wuhan and China, respectively. PM 2.5 fell by 1.4 μg/m^3 in Wuhan but decreased by 18.9 μg/m^3 in 367 cities.

On the other hand, the readings from the Copernicus Sentinel-5P satellite show a significant decrease in NO_2 concentrations over Rome, Madrid, and Paris, the first cities in Europe to implement strict quarantine measures. Fig. 2 shows average NO_2 concentrations from 14 to 25 March 2020 (panel b), compared to the monthly average of concentrations from 2019 (panel a).

Additionally, the Copernicus Atmosphere Monitoring Service (CAMS) of the European Union observed a drop of PM 2.5 last February in relation to the previous three years. According to CAMS (2020), a drop of approximately 20–30% of PM 2.5 is observed in large parts of China, when comparing the difference between the monthly average for February 2020 and the mean of the monthly averages for February 2017, 2018, and 2019.

In China alone, all of these air quality improvements generated human health benefits that have outnumbered confirmed SARS-CoV2 deaths thus far (Chen et al., 2020).

2.2. Clean beaches

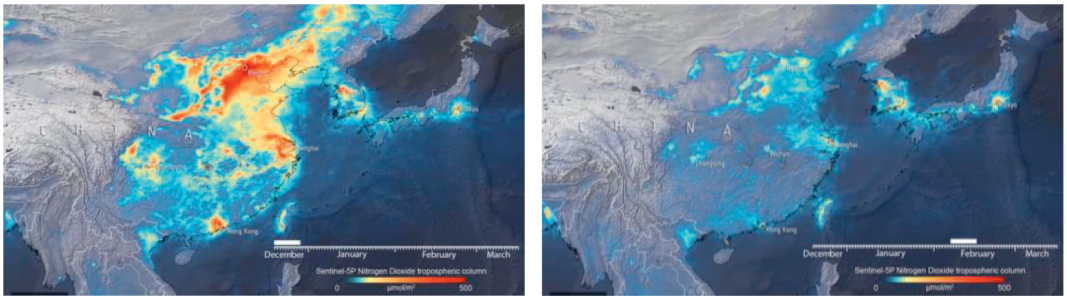
Beaches are one of the most important natural capital assets found in coastal areas (Zambrano-Monserrate et al., 2018). They provide services (land, sand, recreation, and tourism) that are critical to the survival of coastal communities and possess intrinsic values that must be protected from overexploitation (Lucrezi et al., 2016). However, non-responsible use by people has caused many beaches in the world to present pollution problems (Partelow et al., 2015).

The lack of tourists, as a result of the social distancing measures due to the new coronavirus pandemic, has caused a notable change in the appearance of many beaches in the world. For example, beaches like those of Acapulco (Mexico), Barcelona (Spain), or Salinas (Ecuador) now look cleaner and with crystal clear waters.

2.3. Reduction of environmental noise level

Environmental noise is defined as an unwanted sound that could be generated by anthropogenic activities (for instance, industrial or commercial activities), the transit of engine vehicles, and melodies at high volume. Environmental noise is one of the main sources of discomfort for the population and the environment, causing health problems and altering the natural conditions of the ecosystems (Zambrano-Monserrate and Ruano, 2019).

The imposition of quarantine measures by most governments has caused people to stay at home. With this, the use of private and public



(a) (b)

Fig. 1. Evolution of NO_2 concentrations in China.
Source: ESA (2020a).

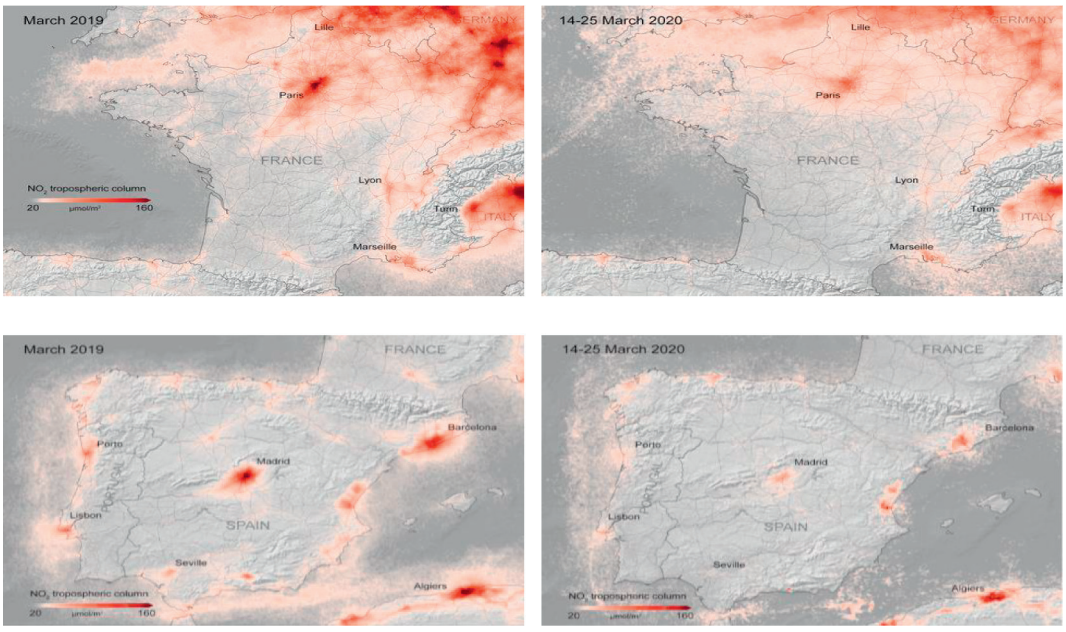


Fig. 2. Evolution of NO_2 concentrations in some regions of Europe.
Source: ESA (2020b).

transportation has decreased significantly. Also, commercial activities have stopped almost entirely. All these changes have caused the noise level to drop considerably in most cities in the world.

2.4. Increased waste

The generation of organic and inorganic waste is indirectly accompanied by a wide range of environmental issues, such as soil erosion, deforestation, air, and water pollution (Mourad, 2016; Schanes et al., 2018).

The quarantine policies, established in most countries, have led consumers to increase their demand for online shopping for home delivery. Consequently, organic waste generated by households has increased. Also, food purchased online is shipped packed, so inorganic waste has also increased.

Medical waste is also on the rise. Hospitals in Wuhan produced an average of 240 metric tons of medical waste per day during the outbreak, compared to their previous average of fewer than 50 tons. In other countries such as the USA, there has been an increase in garbage from personal protective equipment such as masks and gloves (Calma, 2020).

2.5. Reduction in waste recycling

Waste recycling has always been a major environmental problem of interest to all countries (Liu et al., 2020). Recycling is a common and effective way to prevent pollution, save energy, and conserve natural resources (Varotto and Spagnolli, 2017; Ma et al., 2019). As a result of the pandemic, countries such as the USA have stopped recycling programs in some of their cities, as authorities have been concerned about the risk of COVID-19 spreading in recycling centers. In particularly affected European countries, waste management has been restricted. For example, Italy has prohibited infected residents from sorting their waste.

Also, the industry has seized the opportunity to repeal disposable bag bans, even though single-use plastic can still harbor viruses and bacteria (Bir, 2020).

2.6. Other indirect effects on the environment

China has asked wastewater treatment plants to strengthen their disinfection routines (mainly through increased use of chlorine) to prevent the new coronavirus from spreading through the wastewater. However, there is no evidence on the survival of the SARS-CoV2 virus in drinking water or wastewater (WHO, 2020b). On the contrary, the excess of chlorine in the water could generate harmful effects on people's health (Koivusalo and Vartiainen, 1997).

3. Discussion

This research aims to expose the first indirect effects that the new coronavirus has had on the environment. The positive and negative indirect effects are highlighted. The positive indirect effects revolve around the reduction of PM 2.5 and NO_2 concentrations in China, France, Germany, Spain, and Italy. Precisely the high concentrations of these gases are one of the greatest environmental problems of developed countries (Sharma and Dhar, 2018). Also, the quality improvement of the beaches and the reduction of environmental noise were highlighted as positive indirect effects. On the other hand, among the negative indirect effects, the increase in domestic and medical waste were mentioned. The restriction to recycle waste in countries like the USA and Italy has been another negative indirect effect of SARS-CoV2.

It is essential to mention that although the emissions of some GHGs have decreased as a result of the pandemic, this reduction could have little impact on the total concentrations of GHGs that have accumulated in the atmosphere for decades. For a significant decline, there should be a long-term structural change in the countries' economies. This result can be achieved through the ratification of the environmental commitments made. Furthermore, the decrease in GHG emissions currently observed in some countries is only temporary. Since once the pandemic ends, countries will most likely revive their economies, and GHG emissions will skyrocket again.

On the other hand, the safe management of domestic waste could be critical during the COVID-19 emergency. Medical waste such as contaminated masks, gloves, used or expired medications, and other items can

easily be mixed with domestic waste. However, they should be treated as hazardous waste and disposed of separately. Furthermore, these type of waste must be collected by specialized municipal operators or waste management operators (UN, 2020). Along these same lines, the UN Environment Program urged governments to treat waste management, including medical, domestic, and other waste, as an urgent and essential public service to minimize possible secondary health and environmental effects (ARCplus, 2020).

Finally, it is concluded that COVID-19 will produce both positive and negative indirect effects on the environment, but the latter will be greater. Decreasing GHG concentrations during a short period is not a sustainable way to clean up our environment. Furthermore, the virus crisis brings other environmental problems that may last longer and maybe more challenging to manage if countries neglect the impact of the epidemic on the environment.

CRediT authorship contribution statement

Manuel A. Zambrano-Monserrate: Conceptualization, Investigation, Writing - original draft.**María Alejandra Ruano:**Writing - review & editing, Visualization.**Luis Sanchez-Alcalde:**Investigation.

Declaration of competing interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

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