COVID-19 Impacts on the Sustainable Development in Latin America: An Investigation on the Environmental Law and Policy

Nima Norouzi\(^1\), Elham Ataei\(^2\)

\(^1\) School of law and legal studies, Islamic Azad University, Tehran, Iran.
\(^2\) School of Political Science, Payam Noor University, Tehran, Iran.

*Correspondence: n.nima1376@gmail.com

Abstract: The economic and social effects that the COVID-19 pandemic and the associated measures to address it are having in Latin America may lead to serious long-term consequences that would affect the achievement of the Sustainable Development Goals. In this article, the collaboration of environmental economists from eight countries in the region discusses the possible effects of the pandemic on air pollution, deforestation, and other relevant environmental aspects related to the SDGs. In addition to presenting an account of some of the initial effects of the health crisis on the environment, the paper discusses potential effects in terms of environmental regulations and public policy interventions. Finally, the paper presents an agenda on new research topics that arise due to the pandemic or have gained greater importance due to it, including the impacts on the achievement of the Sustainable Development Goals. Briefly, this paper is a novel view of the sustainable development in Latin America and the Covid-19 impacts on this process.

Keywords: Covid-19; environmental impacts; Sustainable Development Goals; pandemic; Environmental law

1. Introduction

On February 25, 2020, the Brazilian Health Secretary confirmed that a 61-year-old man, who had recently traveled to northern Italy, tested positive for SARS-CoV-2: COVID-19 had reached America Latina \([1]\). No time is appropriate for the arrival of a pandemic; however, these are especially complex times for Latin America. The region is in the midst of a difficult economic situation accompanied by social unrest \([2,3]\). Growth in the 2014-2019 period was the lowest recorded since the 1950s \([4]\); In 2019, growth was zero or negative for some countries, such as Nicaragua -3.9%, Argentina -2.2%, Mexico -0.3%, and Paraguay 0% \([5]\). In addition, Brazil and Mexico are still experiencing the consequences of highly polarized presidential elections in 2018, while Bolivia, Chile, Colombia, Ecuador, and Venezuela witnessed massive civil protests in 2019.

Furthermore, the region continues to be characterized by high rates of informality \([5]\), with limited and unequal health systems and high debt rates in most countries \([3]\). These factors will exacerbate the impacts of the crisis and make it difficult for governments to respond adequately. Undoubtedly, the environment will also be affected and, therefore, the possibilities of the region’s countries to achieve the Sustainable Development Goals (SDGs).

COVID-19 and the measures to deal with it present serious effects in the short term with possible serious consequences in the long term in the economic and social spheres, including various consequences for the environment and the management of natural resources in the region. The immediate impacts of both the pandemic and the measures to
manage it include a significant reduction in economic activity and an increase in unemployment rates, with repercussions on poverty and social conditions. Perhaps, the environmental consequences are more uncertain but equally crucial for advancing sustainable development in the region and fulfilling the SDGs and the different interrelationships between social, economic, and environmental objectives\cite{6, 7}. This article discusses the possible effects of the pandemic on air pollution, deforestation, and other relevant environmental dimensions in Latin America. We analyze both the initial and expected environmental effects of this health crisis. Our analysis includes a brief discussion regarding the implications of such effects in the 2030 Agenda for Sustainable Development framework. Finally, we discuss the potential effects of environmental regulations and possible public interventions and suggest a future research agenda for those interested in designing and evaluating relevant environmental policies in the Latin American context.

1.1. The COVID-19 pandemic in Latin America

At the start of the pandemic, Latin America accounted for a small percentage of COVID-19 cases and deaths. Sadly, that is no longer the case. As of August 28, 2020, nearly seven million confirmed cases were reported in the region, compared to 1.8 million in the European Union and 5.9 million in the United States. As Table 1 shows, Brazil has the highest number of confirmed cases (3,761,391), while Uruguay has the least\cite{8, 9}. Figure 1 presents the trajectory of confirmed cases in various countries and regions after their 100th case was confirmed. Except for Cuba and Uruguay, which have relatively flat curves and appear to spread the virus under control, the rest of the countries still have steep curves\cite{12}. Figure 1 shows that Brazil is the country with the most confirmed deaths in the region (it is, in fact, the second worldwide after the United States), followed by Mexico (third in the world) and Peru (ninth in the world). Uruguay is the country with the lowest number of deaths in Latin America\cite{10, 11}.

When comparing confirmed cases between countries, it is necessary to bear in mind that each has followed different epidemiological strategies and, therefore, testing rates are not the same in all settings. The heterogeneity of the data presented in Table 1 clearly shows the large differences in the rate of total tests per 1000 people; While Chile has carried out almost 121 tests per thousand inhabitants, the rate in Mexico is nine tests per thousand inhabitants. Considering this, it is clear that for comparisons between countries, it is more appropriate to use the number of deaths per capita. Figure 2 shows that Peru is the country with the most deaths per million globally (more than 860). In panel (b), it can be seen that the rates of Chile and Brazil are above the rate of the United States (550.9) and not far from those of Spain (616.3) and the United Kingdom (621.9). Eight Latin American countries are among the 15 countries in the world with the highest per-capita mortality rates. When analyzing the data, one thing is clear: Latin America has been severely affected by the COVID-19 pandemic, with more than 270,000 deaths as of July 28, 2020, almost double that of the European Union (139,167). Unfortunately, the trend shown in Figures 1 and 2 suggests that the first wave of the pandemic in the region is far from over\cite{12-15}. 




Table 1. Economic and COVID-19 information

| Country          | Cases confirmed | Confirmed deaths | Total tests per 1000 people | GDP growth rate for 2020 (%) | Fiscal stimulus (% GDP) |
|------------------|-----------------|------------------|----------------------------|-----------------------------|-------------------------|
| Argentina        | 380297          | 8051             | 19.85                      | -7.2                        | 5.1                     |
| Bolivia          | 113130          | 4792             | 19.2                       | -5.8                        | 1.1                     |
| Brasil           | 3761391         | 118648           | 22.7                       | -8.1                        | 11.7                    |
| Chile            | 404103          | 11073            | 120.4                      | -4.2                        | 10.2                    |
| Colombia         | 581996          | 18468            | 49.6                       | -4.8                        | 2.9                     |
| Costa Rica       | 37293           | 398              | 23.5                       | -3.2                        | 0.6                     |
| Cuba             | 3805            | 91               | 33.2                       | -                           | -                       |
| Ecuador          | 111218          | 6472             | 14.2                       | -7.3                        | 0.6                     |
| El Salvador      | 25285           | 695              | 46.73                      | -5.3                        | 1.3                     |
| Guatemala        | 71857           | 2684             | -                          | -3.1                        | 3.5                     |
| Honduras         | 57670           | 1802             | -                          | -5.7                        | 7.2                     |
| México           | 579915          | 62595            | 9.4                        | -7.4                        | 1.1                     |
| Nicaragua        | 4495            | 138              | -                          | -6.2                        | 0                      |
| Panamá           | 89983           | 1949             | 72.7                       | -2.1                        | 6.7                     |
| Paraguay         | 15291           | 266              | 24.8                       | -2.7                        | 2.4                     |
| Perú             | 613379          | 28125            | 15.5                       | -12.2                       | 7.1                     |
| R. Dominicana    | 92967           | 1631             | -                          | -0.7                        | 4.2                     |
| Uruguay          | 1552            | 42               | 47.9                       | -3.8                        | 1.5                     |
| Venezuela        | 42899           | 359              | -                          | -                           | -                       |

Figure 1. COVID-19 Cases and Confirmed COVID-19 Deaths

*Note: The case figure shows all Latin American countries and the five countries (outside the region) with the highest number of confirmed cases. The death figure shows all Latin American countries and the five countries (outside the region) with the highest number of confirmed deaths. Source: own estimate using data from JH-CSSE (2020) updated as of August 28, 2020
The countries of the region have implemented various measures to reduce the spread of the disease. For example, on March 11, El Salvador was the first country in the area to close its borders [17].

At the beginning of May, almost all the countries in the region had closed schools and borders (totally or partially) and implemented measures to close public spaces and limit social congregations [18]. In addition, many countries have implemented curfews and quarantine orders with different levels of implementation [19]. These measures are having, as in the rest of the world, severe economic implications. Microsimulations for Argentina, Brazil, Colombia, and Mexico show that the negative effects on income will be considerable, affecting in a greater way those households whose income is in the middle part of the distribution [20]. In addition to these local disruptions, the pandemic’s global chaos has brought to the economic system, reducing the prices of raw materials and the interruption of tourism, affecting Latin America more than other regions of the world [21].

Today, many countries implement significant fiscal stimulus plans to cushion these effects, even despite the limited fiscal space they have due to their high indebtedness [22]. As of August 28, Brazil and Chile are the countries with the most aggressive fiscal stimulus plans, followed by Honduras, Peru, and Panama (see Table 1). Cuba, Mexico, Nicaragua, and Venezuela are the only countries in Latin America that have not implemented income support programs, while Mexico and Nicaragua are the only ones not granting their citizens debt relief programs [23]. Despite these efforts, in 2020, all the region’s countries are expected to experience a decline in GDP, in some cases by more than 7% (see Table 1). The pandemic negatively affects employment, the fight against poverty, and the region’s reduction [24]. In addition to these economic impacts, the health crisis and social

Figure 2. Deaths from COVID-19 adjusted by population

*Note: Panel (a) shows the Latin American countries that have 500 deaths or more. Panel (b) shows the 15 countries in the world that have the highest per-capita death rates. The falls in the rates reported for Belgium, the United Kingdom, and Spain are due to changes in how those countries count confirmed deaths. Source: own estimate using data from JH-CSSE (2020) updated as of August 28, 2020.
distancing measures have increased gender violence [19]; Since the implementation of the lockdown, emergency calls for domestic violence have increased considerably in Argentina, Colombia, and Mexico [23, 24].

All of the above shows that the pandemic and the measures taken to contain it produces negative effects on the achievement of SDG 1 (end of poverty), 2 (zero hunger), 3 (health and well-being), 5 (gender equality), 8 (decent work and economic growth) and 10 (reduction of inequalities). In the next section, we argue that the environmental SDGs are also affected by the crisis. The crisis generated by the pandemic is of such magnitude, not only in Latin America but at a global level, that the SDGs will probably have to be rethought [19].

2. Covid-19 and the environment and natural resources

2.1. Air pollution and pandemic

The negative health impacts of air pollution have been extensively documented. Even though polluted air enters the body through the respiratory tract, it has systemic effects that can damage other organs [26-29]. Air pollution is linked to many health problems, including causing premature death in children and adults [30-33]. However, exposure to polluted air and its negative effects is not evenly distributed among the population.

Continuous exposure to air pollution is particularly problematic for a region where a significant part of the economically active population belongs to the informal sector. The wealthiest can move away from highly polluted areas, either temporarily or permanently [32, 33]. Some can even change jobs or buy high-quality equipment for protection (e.g., air masks or air purifiers). In contrast to this situation, those on the lower side of the income distribution tend to live in areas with higher traffic density or near sources of pollution (e.g., power plants or industrial complexes), they have to walk long distances to take public transport or even work on the streets [34-36]. The same is usually true of their exposure to indoor air pollution since firewood use is negatively correlated with income; Long-term exposure to indoor pollution can be particularly high for women involved in domestic work [37].

Since air pollution can be a significant cause of pre-existing conditions associated with increased mortality from COVID-19, it has been argued that prolonged exposure to air pollution has made the population more vulnerable to the disease [38, 39]. In the case of the Metropolitan Area of the Valley of Mexico, it has been found that, indeed, there is a positive relationship between prolonged exposure to PM2.5 and the probability of dying from COVID-19 [40].

Current exposure to air pollution can contribute to the spread of the disease. This is based on the possibility that the SARS-CoV-2 virus is present in particulate matter, as preliminary evidence suggests [41]. If this were the case, the virus could travel on the surface of this particulate material to the lungs [42]. Although the role of air pollution in the airborne transmission of the virus is still uncertain, results in China suggest that there would be a positive relationship between the presence of pollutants in the air and COVID-19 infection [43]. If extended periods of exposure to pollution increase the associated risk of contracting the disease [44], informal workers could be one of the most vulnerable populations.

Restrictions to control and reduce movement between and through urban areas in the region have decreased economic activity and the use of cars, trucks, and other motorized vehicles. As a result, as in other large cities globally, many cities in Latin America have experienced a reduction in air pollution in the short term. As shown in Figure 3, NO2 concentrations have decreased considerably in cities throughout the region, compared to the levels observed during the first ten days of March (before the containment measures). Bogotá shows the greatest reduction (~83%), while in Guayaquil, Rio de Janeiro, and Sao Paulo, it was less than 30%. In Bogotá, PM2.5 emissions decreased by 60% [33], while
PM10, PM2.5, and CO were reduced by at least 50% in Buenos Aires compared to the same period of the previous year [45]. Meanwhile, in Quito, Ecuador’s most populous city, PM10 and PM2.5 concentrations had a substantial average daily drop from 25-50 μg/m³ two months before the pandemic to 4-7 μg/m³ during the quarantine [46].

However, in some Latin American cities, the changes observed in the concentrations of some pollutants are relatively small or even positive. These concentrations are the result of a complex process that, in addition to emission levels, depend, among other things, on atmospheric conditions, topographic characteristics, and the interaction between different compounds and pollutants. For example, in Mexico City, even though traffic congestion has decreased [47], the reductions in SO₂, PM2.5 and PM10 have been modest, and there has been no reduction in ozone. Meanwhile, in Rio de Janeiro, the partial confinement of the population led to an increase in ozone concentrations [48-55].

![Figure 3. Changes in NO₂ concentrations (First ten days of March 2020 versus periods of 10 consecutive days)](source: own estimate with data from ref. [13, 44])

Other events, such as wildfires and weather conditions, could also have significant effects on air quality. Bogotá and other cities in Colombia experienced several events of worsening air quality during confinement, apparently due to forest fires in Venezuela and other regions of the country. Although mobility in some of the main cities in central and southern Chile has declined under confinement, air quality could deteriorate during the winter months. Many families in this region use firewood for heating and, as they spend more time indoors, there could be an increase in the concentration of particulate material both indoors and outdoors [12]. A similar effect is expected to be seen as the crisis deepens and the pandemic reaches rural areas. In Mexico, approximately 28 million people live in households that use firewood as their primary or secondary energy source for cooking [45, 46]. As such, they are chronically exposed to indoor pollution and are particularly vulnerable to COVID-19.

As a consequence of the pandemic, the income of many households located in rural and peri-urban areas has been negatively affected. In addition, the reduction in income and problems with the distribution of LP gas in relatively isolated communities have led
to an increase in the use of firewood [17], which could increase the risk associated with the COVID-19.

In any case, the improvements in air quality observed in some Latin American cities are unlikely to be sustainable over time. Pollution levels before confinement could gradually return as confinement measures are relaxed and cities regain their mobility and resume economic activities. Whether some of the mobility measures implemented in cities such as Bogotá, Quito, and Mexico City will remain long-term (e.g., dedicated bike lanes and wider pedestrian zones) remains to be seen. The same is true for the increase in bicycle use observed in Costa Rica due to government restrictions on private cars during certain hours of the day. Beyond the improvements in air quality, it is possible that some workers, after having been forced to use bicycles, maintain this habit as a transport alternative in the long term. An important factor that could increase and preserve this effect is implementing public policies that encourage and even subsidize bicycles as a means of transportation. However, before promoting such policies, it is recommended that the effects that greater exposure to environmental pollution may have on the health of those who use bicycles as a means of transport be analyzed.

The impacts of the pandemic mentioned in this section on air pollution are related to several SDGs. In particular, with SDG 3, 7 (affordable and clean energy), 11 (sustainable cities and communities), and 13 (action for climate), which establish goals regarding 1) substantially reduce the number of deaths and illnesses produced by air pollution; 2) ensure access to affordable, reliable, sustainable and modern energy for all; 3) achieve sustainable cities and communities, and; 4) take measures aimed at combating climate change and its effects. Our analysis suggests short-term effects that could, in some cases, favor the achievement of these goals but also generate additional obstacles. In the first case, everything indicates that improving air quality in cities will disappear as restrictions on movement are reduced. Meanwhile, due to the economic impacts of the pandemic, the use of low-cost energy sources is likely to increase. This could mean, for example, slowing down energy transition processes or even reversing them. Thus, the short-term reductions in air pollution that have been observed in some countries will not be sufficient to achieve the goals set out in the SDGs; Achieving these objectives requires explicit and targeted interventions[56, 56].

2.2. Deforestation in the time of the pandemic

Forests are essential for the preservation of biodiversity and the regulation of the climate. In particular, the Amazon is crucial to maintaining the planet’s health due to its fundamental role in regulating the Earth’s climate [44]. In addition to being a source of food, medicine, and raw material, forests play a key role in the subsistence of rural households [57]. The extraction of non-timber products (e.g., wild animals, wild plants, and fungi) can be an important source of income and provide part of the daily diet for many vulnerable households [46] in a way that alleviates poverty and reduces inequality [48]. Likewise, there is evidence that forests in Latin America provide a type of insurance for households affected by negative shocks [47-51]. In addition, Well-conserved forest ecosystems reduce disease prevalence [52]. On the other hand, deforestation and changes in land use can alter interactions between man and animals, generating the potential for the transmission of zoonotic infections from animal populations to humans, as appears to have occurred with COVID-19; approximately 75% of emerging infections are zoonotic [22].

It is still too early to carry out a formal assessment of the effects of the pandemic on deforestation and changes in land use in the region. However, available information suggests that measures taken to manage COVID-19 are likely to affect forest cover negatively. In Mexico, reports from different country regions (Hidalgo, Tlaxcala, Chihuahua, and the Yucatan Peninsula) show an increase in illegal deforestation in the last two months. Early
signs of deforestation in Peru show how even though deforestation in the period has decreased between March 15 and April 15, after this date, it increased, surpassing the levels observed in the same period in 2018. Overall, deforestation rates in Amazon countries were increasing before the COVID-19 emergency, a trend that the pandemic and associated lockdown will not help reverse. On the contrary, the reduction in monitoring efforts throughout the region during the pandemic could be associated with increased forest clearing and carbon emissions due to changes in land use.

According to data from the National Institute for Space Research of Brazil (INPE), the first quarter of 2020 already showed a 50% increase in the number of hectares deforested than the previous year’s statistics [58]. The figures for April 2020 reinforce this trend with an increase of 64% compared to April 2019. Furthermore, from January to April 2020, alerts for deforestation in indigenous territories increased 59% compared to the same period of the previous year. Although these increases cannot be attributed to the measures taken by the pandemic at this time, it certainly does not seem to have generated incentives to stop them. Additionally, another concern for Brazil and other countries in the region, such as Colombia, is that an increase in deforestation may lead to even more forest fires than those that occurred the previous year. The evidence shows that the confinement accompanying the pandemic in Colombia is associated with increased forest fires [54].

Contrary to other countries in the Amazon area, Colombia reduced deforestation in 2019 compared to 2018 [59-66]. However, 2020 began with an upward trend, and the confinement seems to have aggravated the situation. In addition, the absence of environmental monitoring during the pandemic seems to have encouraged armed groups and regional mafias, exacerbating deforestation and intensifying illegal activities from which these actors derive income, such as illegal mining, land grabbing, and illicit crops [56].

For Bolivia, Brazil, Colombia, Ecuador, and Peru, the Amazon region is also very important in ethnic diversity. The same is true for some forests in Costa Rica, Guatemala, Honduras, Mexico, Nicaragua, and Panama. Recent studies have documented indigenous and ethnic reserves’ impact in reducing deforestation and carbon emissions in the Amazon [57] and other forests in the region [58]. Therefore, the spread of the virus and the impact of the pandemic on ethnic communities in these and other regions is a major source of concern [67-79]. For example, in Ecuador, the Amazon Region registers 10,265 cases of COVID-19 accumulated since the beginning of the pandemic, and this figure means that this region has the highest incidence rate of the virus in the country [60].

According to the Pan American Health Organization, there are 20,000 confirmed cases of COVID-19 in the Amazon Basin [9]. Gold miners and illegal loggers expose indigenous communities to considerable health risks, a situation that could have severe consequences given the poor response capacity of hospitals and health services in the region. In Colombia, most—if not all — departments in the Amazon region lack intensive care units [11]. Therefore, the spread of the virus in these communities could imply a tragedy that, in addition to the human losses, could, in turn, affect traditional knowledge and produce negative effects on the governance of the region. As a result, there could be even more deforestation in the future. Therefore, differential policies to serve ethnic populations in the region are an urgent need [12].

An increase in deforestation in the region would negatively affect the goals proposed by SDG 15 (terrestrial life and ecosystem) and 13, which aim to (1) put an end to deforestation and recover degraded forests; and 2) reduce greenhouse gas emissions from changes in land use. In addition, the interrelation between this and other objectives could also negatively affect SDGs 1, 2, and 3 due to the dependence that both rural and urban populations have on the ecosystem services provided by forests.

2.3. Other impacts on the environment and natural resources

COVID-19 has disrupted the national and international exchange of goods and services related to natural resources. As a result, tourism has stopped, which has affected the
economy of almost all countries in the region. In countries like Costa Rica, where the tourism industry is intertwined with nature, the impact on the sector could have negative effects on biodiversity and forests. Without the income from tourism, particularly from nature tourism, the incentives for forest protection are diminished in the short and medium-term. Furthermore, the loss of jobs in the sector could lead unemployed workers to seek alternative sources of income within the forests. In general, extraction activities, such as mining within protected areas, could easily increase due to the pressing need of the nearby population. Furthermore, alternative land uses (e.g., agriculture and livestock) could represent attractive sources of income.

Aquaculture and fishing are other industries that have been negatively affected. Information from the Chilean salmon industry suggests two different types of consequences so far. First, a reduction in demand from international markets, especially important in the first months of the year, is due to mobility restrictions, border closures, and general transportation costs [80]. Second, restrictions imposed by some coastal communities on worker mobility due to fear of the spread of COVID-19 could result in a shortage of labor and services to adequately manage and care for salmon biomass [62]. In Ecuador, in the Galápagos province, 60% of the demand for locally sourced fish and shellfish comes from the tourism sector. Given the paralysis of tourist activities, we can assume that the demand for these products has fallen significantly, strongly hitting the economy of the artisanal fishing sector of the islands.

The impact of tourism and the fishing industry can negatively affect SDG 8 in terms of growth and employment, but it can positively affect SDG 15 and 14 (underwater life) goals. Determining the net effect is an empirical question that requires future research[81].

3. Covid-19 and environmental policies and law

The economic crisis may end up having negative environmental repercussions in the long term if, as a result of policies, environmental regulations are relaxed or if institutions are weakened[82]. Although there is no evidence that countries are relaxing their environmental regulations to promote growth, it is certainly a possibility, especially due to pressure from the private sector. What has been observed is that to finance measures to reduce the economic and social impacts of the pandemic, some countries have decided to reallocate funds within the public administration. For example, Ecuador announced cuts in most government ministries, including Environment and Water, responsible for implementing regulations for administering the environment and natural resources and the national system of protected areas [83]. Something similar is happening in Mexico, where the plan announced by the president is to reduce the operating budget of almost all government entities by 75% [84]. In Colombia, for example, the government made a proposal to cut the National Parks budget in the 2021 budget project, recently presented for consideration by Congress. These cuts imply that entities related to natural resource management may not be in a position to fulfill their mission and achieve the goals associated with SDG 13, 14, and 15, among others. Even if countries have relatively strong legal frameworks, they are useless without a budget to back them up. As a result, the region’s countries will most likely run into fiscal deficits and increase their debts to face the crisis. It remains to be seen how much this increase in debt service will impact economic growth and the environment in the medium term. Meanwhile, the pandemic causes negative impacts on the fulfillment of the social goals associated with SDGs 1, 2, 3, 4 (quality education), 5, 8, and 10, leaving the region in a precarious situation and with few resources to advance the environmental goals associated with SDGs 13, 14 and 15, among others[85].

4. Discussion

The pandemic and containment measures appear to have had an initial temporary effect in reducing urban pollution in many Latin American cities. The challenge now is
how to intervene to prevent an immediate return to previous - or even higher - levels of emissions. It is an opportunity to rethink urban environmental policies to achieve SDG 11 as society tries to recover from an unprecedented social crisis. At the same time, the observed increase in deforestation reopens academic and political debates about the role of national parks, indigenous reserves, and other categories of protection in a context of deteriorated lifestyles, illegal economies, and a lack of state presence\[12, 86-93\].

Economic projections suggest that the region will experience a crisis whose magnitude is unprecedented in modern history. To overcome this seemingly insurmountable challenge, Latin American countries will require well-designed policies that must reconcile economic objectives with social and environmental goals, as set out in the sustainable development goals and regional goals. The social discontent manifested in the recent mobilizations in the region should clarify that the apparent contrast between economic, social, and environmental objectives is nothing more than the result of a false dichotomy between short-term and long-term objectives\[19\]. If environmental goals are neglected, as social goals have often been, the economy could recover in the short term, but at a very high social and environmental cost\[32,94-97\].

Latin American countries should see this moment as an opportunity to improve regional cooperation to design and implement coordinated response policies to face the economic crisis and address the challenge posed by climate change and the achievement of sustainable development goals. The countries of the Amazon Basin and those of Central America should coordinate efforts to improve monitoring and presence in the region to reduce deforestation effectively\[38\].

Considerations on food safety and autonomy, articulation with traditional health systems, and good marketing products with nearby urban centers will be decisive in preventing COVID-19 in remote regions \[17\]. In this context, voluntary isolation from traditional communities should be considered whenever possible. Therefore, it is necessary to implement coordination between governments and ethnic authorities \[29\]. Environmental, safety, and health policies should be articulated to strengthen the governance processes of the Amazon and other regions with ethnic communities.

Mitigation and adaptation to climate change is another area where cooperation could be decisive for the region’s countries to comply with their Nationally Determined Contributions under the Paris Agreement and the goals of SDG 13\[64-68\].

Considering that we are in the middle of a health and economic crisis, it is natural to expect that the trends observed so far will change in the following months and that other environmental impacts will become evident. Research that contributes to a better understanding of environmental impacts and the effectiveness of different policy responses to the pandemic in Latin America will be invaluable. There are many potential avenues for future research; only a few are mentioned here\[98-102\].

Poor air quality can increase not only the likelihood of COVID-19 infections but also increase fatality. The human health consequences of interactions between COVID-19 and poor air quality are certainly worth studying. This is particularly relevant in the Latin American context, characterized by health systems with limited capacity and a high percentage of the population without formal employment. The results of studies in this area could help us define environmental quality goals and implement intervention policies that reduce pollution in the region in its current context of income inequality, heterogeneous sources of pollution, and spatial segregation\[103\].

The short-term effects of COVID-19 show early signs of increased pressure on ecosystems and forests throughout Latin America. At this time, the magnitude of the impact and its timing is not yet clear. The answers to these questions could help us better understand the role that forests play for different agents in various circumstances and how this is reflected in deforestation and land-use change. This information has the potential to contribute to the design of policies that could improve the management and conservation of natural resources and the achievement of sustainable development goals. Studying the
impacts of the pandemic on the conservation of marine resources and the livelihood opportunities of local coastal communities is another relevant area of research.[44, 104-107].

5. Conclusion

Today the pandemic opens new research questions regarding the effects of global shocks on industries based on natural resources that participate in international markets. This crisis has shown that these industries are vulnerable to unknown threats, but it is unclear why the different degrees of vulnerability is due. Furthermore, the paths that different countries have taken to emerge from the economic crisis could profoundly impact international trade. If, for example, the world shifts to a greater dependence on local production, or if emissions-related tariffs are imposed, the region’s large exporters of raw materials would be hit hard. The impacts that these possible commercial changes would have on the environment are unknown.

Likewise, it is unknown how greenhouse emissions will change in the long term in response to the pandemic. If developed countries implement recovery plans that include provisions to reduce emissions, as discussed in the European Union significantly, will Latin American countries respond in the same way? In any case, these countries are highly vulnerable to climate change, and some of these effects could result in future health crises. If, for example, climate change encourages migration, it could result in additional interactions between animal and human species, thereby increasing the possibility of new infectious diseases emerging. A better understanding of how individuals could adapt to climate change and the barriers they face when adopting adaptation measures will be an invaluable tool for designing adaptation policies to prevent future health crises.

The distributional and gender impacts of the pandemic and the consequent environmental policy responses are another area that deserves attention, especially since early evidence shows that the most vulnerable segments of the region are those that are being most severely affected. Finally, as recently pointed out by Helm, the experience of the COVID-19 pandemic could lead to permanent changes in both behavior and individual choices. It remains to be seen if this is real, and if it was, how the local context shapes these eventual changes in behavior. A particularly important issue to consider is what these changes might imply for the design of behavior-based policy instruments focused on modifying consumption and production patterns, as well as transport and land-use decisions.

Finally, COVID-19, its economic impact, and government responses to address the crisis will affect the SDGs’ viability. Thus, monitoring and evaluating compliance with the Sustainable Development Agenda, the difficulties in achieving it, and the design and evaluation of policy alternatives constitute an important area of future research in the region. The same can be said about understanding the interrelationships and tensions between the SDGs’ goals in a post-COVID world.

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