



## Evaluation of environmental impacts of the Covid-19 on the Iran: an updated review

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### ABSTRACT

The COVID-19 started from Wuhan, China by the end of 2019 and spread rapidly around the world. Since December 2019, COVID-19 disease has spread rapidly in all regions of the world, from cold and dry to hot and humid climates. The virus resulted in about 4.2 million infections and 280,000 deaths around the world (as of 10<sup>th</sup> May, 2020). But it has resulted in about 154.4 million infections and 3.3 million deaths around the world (as of 10<sup>th</sup> May, 2021). It means that infection cases have grown about 37 time and death cases about 12 times during the said interval. The virus resulted about 108,000 infections and 6,700 deaths in Iran (as of 10<sup>th</sup> May, 2020). But it has grown to about 2.6 million infections and about 73,300 deaths one year later (as of 10<sup>th</sup> May, 2021). It means that infection cases in Iran are about 24 times and death cases are about 11 times as compared to the global data. The ratios are relatively not far from to average data in the other parts of the world. The world has not experienced such catastrophic phenomena after World War I (1914-1918). The catastrophe is affecting not only our health, economy, culture and life style but also our environment. After one year, ideas about role of this crisis in ecosystem and environment are quite different. Optimists believe that this crisis is the best opportunity to reduce pressure on natural resources and provides time for self-reconstruction of the ecosystems and environment. The most positive impacts of this crisis are reduced pressure on natural resources, decrease in air pollution and climate change, deeper understanding of the ecosystems and environment saving. The significant negative impacts of the COVID-19 are human infection, economic losses, increase in household consumption, medicine, face masks, medical gloves, challenge for burial of household and medical waste, reduction in environmental diplomacy, reduction in accuracy of weather forecasts and treat for wildlife infection. Several impacts have been reported on the human and natural environment of Iran. The impacts on the ecosystems and environment of Iran are similar to that reported in other parts of the world.

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### 1. Introduction

The COVID-19 originated from Wuhan, in China and led to the global pandemic. Since December 2019, COVID-19 disease has spread rapidly in every continent and all regions of the world, from cold and dry to hot and humid climates. The observations indicate a human to the human spreading capability of this virus, which was rapidly reported on every continent.

The human to the human spreading of the virus occurs due to close contact with an infected person, exposed to coughing, sneezing, respiratory droplets or aerosols. These aerosols can penetrate the human body (lungs) via inhalation through the nose or mouth. The intermediate source of origin and transfer to humans is not known, however, the rapid human to human transfer has been confirmed widely. About 154,000,000 people around the world were affected by this virus and about 3.3

million have died, till the date of this writing (as of 10<sup>th</sup> May, 2021) (MHME, 2021). This is a serious pandemics global problem on the 21th century. The world has not experienced such catastrophic phenomena after World War I on 1914-1918. This pandemic has affected our life very badly, overloaded hospitals, overloaded graveyards, caused economic disaster and unemployment in many countries. Even it has caused depression and stress in millions of people, because of lockdown and quarantine. The catastrophe is affecting not only our health, economy, culture and life style but also it is going to affect our environment and ecosystem. Understanding how COVID-19 is affecting the ecosystem and different sectors of the environment is of vital importance. There are not yet too many scientific researches about role the virus as a catalyst or inhibitor of different sectors of the ecosystem and environment. The ideas about role of this crisis in various indoor and outdoor environments are quite different. Our environment and ecosystem has suffered from the COVID-19 crisis and has created benefits also. The following paper is dealing to evaluate the negative and positive impacts of this crisis in Our environment and ecosystem after one year.

## 2. Material and Methods

The data used in this article are mainly based on statistics which were obtained from reputable websites such as WHO (World Health Organization), UNEP (United Nation Environmental Protection), Iran's MHME (Ministry of Health and Medical Education), IRNA (Iran News Agency), available policy documents, programs, action plans, reports and even official news related to COVID-19 in Iran. It also obtained the experts' opinions on all aspects of the pandemic effects in our ecosystem and environment to criticize and refine findings. Finally, we compared Iran's measures with UNEP and WHO guidelines, and interpreted the useful data. The paper is dealing to evaluate the negative and positive impacts of this crisis not only on the ecosystem and environment of the world but also on the ecosystem and environment of the Iran. It is important to note that Iran is one of the most infected countries in Asia and evaluation of the negative and positive impacts of this crisis on the ecosystem and environment of Iran is very

important (MHME, 2021). Conducting any research about this crisis can result in better understanding of different environmental and geographical factors which can control the spreading pattern of this pandemic.

## 3. Results and discussion

### 3.1. Negative impacts

After one year, there is no evidence of direct connection between environmental issues, geography, climate change and transmission of COVID-19 disease. However, environmental issue, geography, climate change indirectly affects the COVID-19 response, health systems and additional stress to disease. But it clear that the COVID-19 not only directly threatens our lives, but also it is real challenge for our ecosystem and environment too. It can be evaluating several typical negative impacts for the ecosystem and different sectors of the environment. The current data show that the survival of this virus varying indoor environments factors such as temperature, humidity, different environmental issue, geography, climate change (Ahmadi et al., 2020). The natural life cycle of the virus involves long-distance dissemination mainly in outdoor environments. Therefore, the negative impacts of the virus depend on indoor and outdoor environments factors. The most negative impacts can be categorized as human cost, household consumption, medical consumption.

#### 3.1.1. Human cost

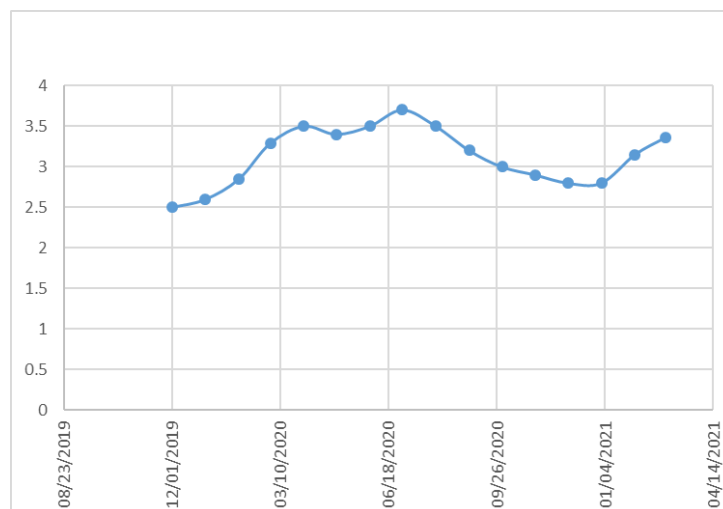
The first negative (the most important) impact of the COVID-19 is human cost. The World Health Organization has declared COVID-19 as the outbreak a pandemic and it has spread to more than 210 countries around the world. The main human cost is more than 144,000,000 infected cases and 3.3 million deaths confirmed globally (WHO, 2021). It is the biggest worldwide death after World War I. The human cost of the CVID-19 in Iran is more than 2.6 million infected cases and 73,300 deaths (MHME, 2021). The data has been updated on the time of writing of the paper on as of 10<sup>th</sup> May, 2021. The second human cost of the Covid-19 is that it hit more the poor peoples at least half of the world's population. The poor families have to pay for

health care and lockdown of business hit their life too. The coronavirus outbreak and quarantines act as poverty multipliers and are forcing their life into extreme poverty not only worldwide but also in Iran.

### 3.1.2. Increasing of household consumption

The second negative impact of the COVID-19 is that it led people to consume more water, electricity, household energy (such as gas), food, hygiene and even medicine. Quarantine and staying home longer increases the working time of the heating and electricity system. This will increase household energy consumption and produces more gas from this sector. One of the main problems is the increase in water and detergent consumption in indoor environment. Excessive use of water causes more sewage to be produced. Increasing wastewater will further threaten groundwater resources and reduce potable water resources. Multiple uses of detergents around the globe dramatically increases the chlorine, phosphate and nitrate of surface water. Due to the abundance of nutrients, algae and aquatic plants grow unusually and cause the wetlands to dry up, and on the other hand, by preventing sunlight from entering the aquatic ecosystems, they destroy their entire vital cycle, as well. Imagine that with these huge changes in the pattern of detergent consumption around the world, if this trend continues, we will see many ecosystem changes in aquatic environments. Access to safe water and sanitation is essential for peoples to practice basic hygiene and reduce transmission of COVID-19. About 80% of the world's population were already

experiencing some level of water scarcity. Climate change further threatens the availability of water for consumption, personal hygiene, and medical care, including infectious disease (Yazdi, 2020). The COVID-19 outbreak has caused increase in water and detergent consumption in Iran similar to other parts of the world. Generally, per capita water consumption in Iran has been higher than world standards and currently each person consumes about 300 liters of water per day (TPWW, 2021). The outbreak of coronavirus has changed the pattern of household water consumption, increasing potable water consumption in the country by 35 percent. According to the official report by TPWW, 2021, in the first few weeks of the pandemic, due to the high sensitivity toward the issue and also the lockdowns, water consumption by households increased significantly. However, this situation did not last for long and gradually the families got used to the new situation and water consumption became more balanced in many provinces of the country (IRNA, 2021). After end of May 2020, because of the beginning of the hot season and the increase in the use of air conditioners, water consumption in Tehran (the largest and most populous city) has increased by 21 percent. Tehran's water consumption increased from 2.850 million cubic meters in February 2020 to 3.124 million cubic meters (11% increasing). Tehran's water consumption increased from 2.5 million cubic meters before coronavirus outbreak to 3.7 million cubic meters in the last summer (Fig.1).



**Fig.1.** Tehran's water consumption increasing after coronavirus outbreak from Dec.2019 to May.2021 (TPWW, 2020-2021).

It was unprecedented in the last 50 years. It is equal to highest level of water consumption during the summer heat time (TPWW, 2021). The water resources of Iran are limited. Therefore, excessive water consumption and increased wastewater are threatening groundwater resources of Iran. The World Health Organization (WHO) stated that it is impossible to become infected with coronavirus through water and the risk of infection of water supply systems is low. But the presence of coronavirus in water was detected during routine tests in four of 27 samples. How the coronavirus got into industrial water is not known (WHO, 20210). About 0.8 mg/l chlorine were used for disinfecting of Tehran drinking water. It is relatively high but it caused the absence of COVID-19 not only in drinking water but also in the raw wastewater (TPWW, 2021).

### 3.1.3. Challenge for burial of household and medical waste

Another negative impact of the COVID-19 is that it led people to use more medicine, significant numbers of face masks, disposable bags and medical gloves. As a consequence, the unprecedented use of disposable face masks and medical gloves added to the worldwide burden of plastic waste. Another problem is that some health centers do not pay attention to the protocols of collecting, disinfecting and disposing of medical and hospital wastes. Also, some peoples do not pay attention to collecting and disinfecting the medical waste. Failure to pay attention to the accumulation of infectious and domestic wastes may lead to polluting and unsanitary of nature and a second wave of epidemics. Since the outbreak of COVID-19, the amount of household and medical waste has increased 3.5 times more comparative to pre-pandemic, the most important reason is increase in protection and hygiene items in the hospital and homes and the tendency to consume certain foods (MHME, 2021). The most medical center and peoples in the developed cities of Iran have observed the protocols of collecting, disinfecting and disposing of medical and hospital wastes (MHME, 2020). For example, Isfahan municipality (the second largest city of Iran) gives people special bags marked in red for collecting medical household wastes (IRNA, 2021). The refuse collectors are aware of the contaminated waste. Another concern is

the pollution caused by the burial of the deceased in cemeteries. Lime slurry and disinfectants are used during the burial. Also, the bodies are buried at a depth of about two meters. Under these conditions, and presence of wastewater rich in detergents and antiseptics, the viruses are killed in less than a minute. The COVID-19 virus has a fat coating and is only activated in the living organism. When the fat coating is removed, the virus also disappears. It is removed by heat above 50 degrees, alcohol, detergents, oxygenated water, lime slurry and any liquid that has alkaline properties (Yazdi, 2020b). Therefore, under these conditions, household and medical waste are relatively safe. There is a general risk that the home wastes will be infectious, because a number of patients spend their illness at home. Also, there is a risk of the virus spreading through rag-pickers during the separation of the plastic wastes from the street recycling bins.

### 3.1.4. Wildlife infection

COVID-19 is caused by a group of related viruses that could cause diseases in mammals and birds. It originally came from an animal, likely a bat. At this time, there is no evidence that animals play a significant role in spreading of COVID-19 to people. Based on the available information to date, the risk of animals spreading COVID-19 to people is considered to be low. But, there *have been* reports of *animals* infected with the virus worldwide. Most of these *animals* became infected after contact with people with *COVID-19*. There are concerns that the virus could be transmitted to animals in the now and future. There is no significant evidence that human coronaviruses can be transmitted by animals until March, 2021. A small number of pet cats and *dogs have been* reported to be infected with *COVID-19* (CDC, 2021). There are other concerns as to whether it is possible to transmit the virus to animals in the future. From an infection control viewpoint, it is already well known that the most infection source of virus is common urban, parks and gardens. Also, legal and illegal wildlife (both live and in parts) are as the most probable sources of the virus. Recent reports show that dogs and domestic cats are probably infected by Covid-19. If this proves to be the case, we will have to wait for a big disaster in the farming and poultry industry,

pets and even wildlife. There is no infection report from Iran wildlife as yet (MHME, 2021). We have had bad experiences such as bird and swine flus in the past. Also, chlorine disinfectants threaten aquatic plants and wildlife in two ways. First, chlorine directly oxidizes to destroy cells or proteins. Second, chemical compounds in disinfectants combine with other substances to become hazardous compounds. In surface waters, the decomposition of organic matter is very intense. For this reason, these compounds lead to the synthesis of by-products such as tri-halo-methane and halo-acetic acid. These compounds are very dangerous for aquatic organisms. In addition, disinfectants are converted to chloramine and Nitro-sodium methylamine, known as carcinogens. All of them are too harmful for aquatic plants and of the world as well as for Iran ecosystem. There are limited report about wildlife infected by COVID-19. The first US case of an animal testing positive for COVID-19 was a tiger at a New York zoo. But there is no such report about Iran's wildlife (IRAN DOE, 2021).

#### *3.1.5. Reduction in accuracy of weather forecasts*

The other negative impact of the COVID-19 is that it led to reduction in accuracy of worldwide weather forecasts. The European Centre for Medium-Range Weather Forecasts (ECMWF) announced that a worldwide reduction in aircraft flights due to the pandemic could impact the accuracy of weather forecasts, citing commercial airlines' use of Aircraft Meteorological Data Relay (AMDAR) as an integral contribution to weather forecast accuracy (DCE, 2020). The ECMWF predicted that AMDAR coverage would decrease by 65% or more due to the drop in commercial flights (IEA, 2020). Commercial aircrafts collect valuable temperature and wind data as they fly. But the pandemic grounded flights, and up to 75% of these daily data disappeared. This caused concern among meteorologists, who use such data to predict both short- and long-term weather. Ying Chen at Lancaster Environment Centre in the UK compared forecasts with global temperature, wind and precipitation data. He found that temperature forecasts between March and May 2020 were less accurate than those from February 2020, by up to 2 °C — a statistically significant change (Nature, 2021).

#### *3.1.6. Environmental diplomacy*

COVID-19 changed everything as well as structures of diplomacy. Even, international efforts to support conflict resolution have also been weakened as diplomats, envoys and peace negotiators have been unable to travel. Virtual and online meetings have long been seen as a poor substitute for face-to-face ones. The COVID-19 pandemic has certainly shaken up old structures of diplomacy and accelerated virtual diplomacy. The pandemic has also impacted face to face environmental and climate diplomacy. For example, the 2020 United Nations Climate Change Conference was postponed to 2021 (Newburger, 2020). After one year experiences, environmental diplomacy to adapt to a new reality and most of the meeting to become online and virtual meeting. Also, the pandemic has limited the ability of countries, particularly developing countries with low state capacity, would see global warming as a lower priority issue than the pandemic and that a desire to "restart" the global economy would cause an excess in extra greenhouse gas production (UNEP, 2021).

#### *3.1.7. Economic impact*

COVID-19 will have the greatest negative impact on the economy of all countries. It seems that this year will be one of the worst years of the economic situation for all countries including Iran. It is set to cause the steepest fall in global GDP (up to 5-6%) since the World War II. According to forecasts, different countries will spend about 10% of their GDP to deal with Covid-19. The governments are facing a severe budget deficit; disrupting the subsidy payment process. This might imply a danger of future inflation and unemployment, more damage to the life of the poor (UNEP, 2021). Significant reductions in income, a rise in unemployment, and disruptions in the transportation, service, and manufacturing industries are among the consequences of the disease mitigation measures that have been implemented in many countries (Fig. 2). It has become clear that most governments in the world underestimated the risks of rapid COVID-19 spread and were mostly reactive in their crisis response. As disease outbreaks are not likely to disappear in the near future, proactive international actions are required to not only save lives but also protect economic prosperity (Pak et al., 2020).

The Iranian economy entered a 4th consecutive year of recession following the triple-shock of sanctions, oil market collapse and COVID-19 crisis. High inflation placed additional economic stress on lower income households following a sharp depreciation of the currency. Government announced that 20% of the country's annual budget would be allocated to fight the virus and requested to withdraw 1 billion dollars from National Development Fund. The research show that changes in employment during the winter of 2019 and spring of 2020 compared to the same seasons of the previous year, had a decreasing trend in employment and an increase in unemployment. These changes, which increased due to the

peak of the COVID-19 outbreak, indicate changes in the labor market and other sectors of the economy that have affected this market (Tahernia et al., 2020). There is some concern about future effects of environmental policy, global markets and investments. Cheap oil may slow down the transition to cleaner energy and green investments. The lowered oil prices usually lead to more travel, more production, and more harmful emissions. The preliminary data suggest that cheap oil could actually lead some companies to decide that renewable sources like wind and solar powers are a safer investment in a world of unstable oil prices (Izvorski et al., 2020).

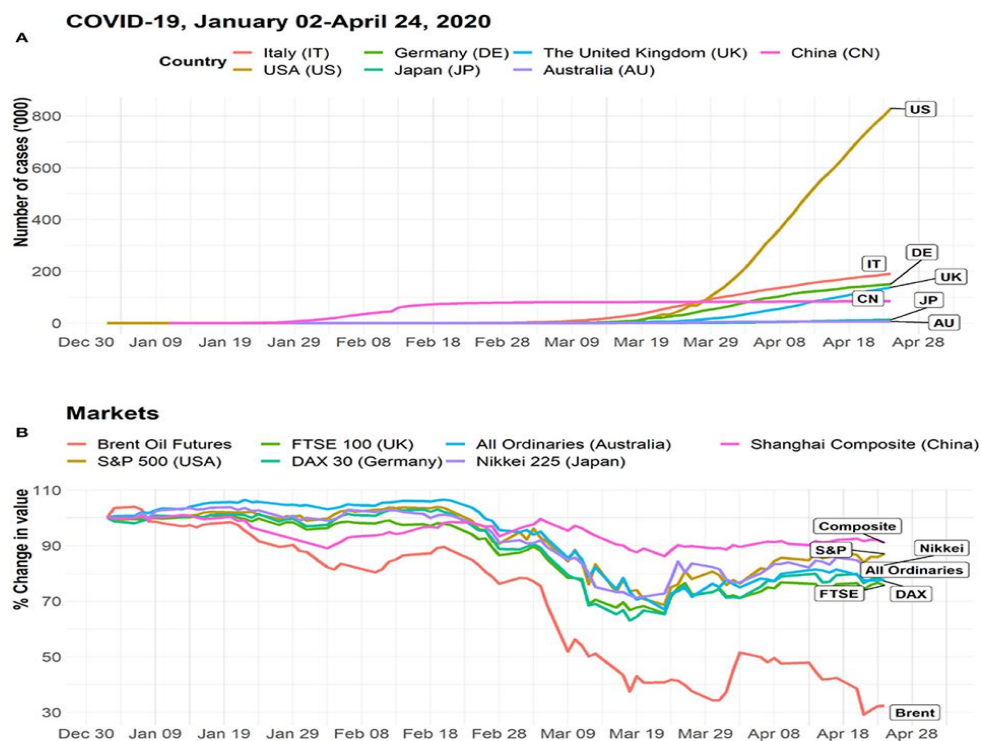


Fig. 2. A) Cumulative number of confirmed cases in emerging epicenters, B) Dynamics of the value of stock indices and oil futures relative to January 2, 2020 (Pak et al., 2020).

### 3.2. Positive impacts

The worldwide disruption caused by the 2019–2020 COVID-19 pandemic has resulted in numerous impacts on the ecosystem and environment. News channels and social media feeds are quick to point out the negatives impacts of COVID-19 crisis, but it has actually resulted in a bunch of positive impacts for our ecosystem and environment (Watts and Kommenda, 2020). In spite of the negative aspects of COVID-19 on the globe, the coronavirus crisis brought a positive impact on the natural environment. Countries where the

movement of citizens was seized to stop the spread of coronavirus infection have experienced a noticeable decline in pollution and greenhouse gases emission. Recent research also indicated that this COVID-19-induced lockdown has reduced the environment Following social distancing and restricted human interaction with nature proved to be a blessing for nature and environment during the crisis. There are positive indications from all over the world that COVID-19-induced lockdown is improving environmental conditions including air and water quality and causes a significant

concurrent reduction in PM<sub>2.5</sub>, NO<sub>2</sub> and CO concentration which resulted in a significant increase in O<sub>3</sub> concentration (Khan and Shah, 2021). Some report showed that a small increase in long-term exposure to particulate matter (PM<sub>2.5</sub>) leads to a large increase in death rate. An increase of just 1 microgram per cubic meter in PM<sub>2.5</sub> increases the COVID-19 death rate by 15% (WHO, 2021). It means that decreasing in PM<sub>2.5</sub> contents decreases significantly the death rate.

### 3.2.1. Self-awareness

COVID-19 teaches us about our response to ecosystem and environment. We know that environmental damage and climate change is a gradually increasing stress that may be the defining public health threat of the 21<sup>st</sup> century. When faced with public health threats of a global scale, such as COVID-19 or climate change, we are only as strong as our weakest health system. Guaranteeing global health security requires an all-hazards approach to preparedness, from infectious disease outbreaks, to extreme weather events, to environmental damage and climate change (PHEIC, 2021). The impact of the COVID-19 may lead to a deeper understanding of the ties that bind us all on a global scale and could help us get to grips with the largest public health threat of the century and the ecosystem and environment crisis. There is no denying the fact that coronavirus has had catastrophic impacts on mankind. However, it has surely given the environment a chance to self-heal and reclaim what belongs to nature. The first principle of ecology is that every action in nature has a reaction. The second principle says that no creature in nature disappears, but changes from one state to another. COVID-19 crisis demonstrated the legitimacy of these two laws, and what a catastrophe it is for mankind to be overly involved in nature and its unnatural behavior to nature. Now, the general public all realize how important it is to follow natural and ecological laws. Any major disaster in the ecosystem, such as the irrational, unnatural, and illegal eating of animals such as bats, could be a catastrophe for the human in the all parts of the world. Before this crisis, we have never had thought about the way we are treating the environment and the scarce natural resources. However, now when due to lockdown we are forced to stay back home, almost all of us have ample time to

think and reflect on our actions. We have now become aware about how we have been wasting water while bathing and brushing, wasting electricity by keeping laptops, computers, televisions on just to save the time and effort of switching them on and off time and again and a lot of similar things (UNEP, 2020). We have found ourselves guilty of having wasted so much food, so much paper and obviously so many natural resources. This guilt of self-realization is helping mankind to eradicate all the wrong that has been done (TGC, 2020). People have become conscious about what they eat. People now are trying to eat more fruits and vegetables. Many have said good bye to meat while others have temporarily paused consumption of non-vegetarian food. People are being forced by the nature to opt for dietary options that are relevant from the view point of sustainable development. This is again a positive indicator as far as health of environment is concerned (TGC, 2020). Behavioral patterns of Iranian change due to the COVID-19 crisis in all issues especially about ecosystem and environment, are similar to that of other people in the world. They are more aware of the importance of access to fresh air, blue sky and low traffic especially in Iran's Metropolises. Although, behavior patterns may be short-lived and people may revert to previous patterns once the crisis is past (Rousseau and Nick, 2020).

### 3.2.2. Slowdown of climate change

There is no evidence of a direct connection between climate change and transmission of COVID-19 disease. However, climate change may indirectly affect the COVID-19 response, as it undermines environmental determinants of health, and places additional stress on health systems. Due to the coronavirus outbreak's impact on travel and industry, many regions experienced a drop in air pollution. Reducing air pollution can reduce climate change. However, reductions in emissions due to lockdown and quarantine are temporary. The countries would attempt to return to previous rates of economic growth and would supply chain disruptions in the energy that will worsen its environmental impact. Therefore, it seems that reduced climate change is impermanent (UNEP, 2020). Many countries around the world as well as Iran have implemented lockdown and quarantine to slow



down the spread of the virus and due to this a lot less air pollution and greenhouse gases being emitted and air quality has improved significantly. The data show that carbon

emissions after COVID-19 lockdown have been significantly decreased in many countries such as UK (48%), Italy (27%), China (18%), Iran (12%) and USA (7.5%) (Fig. 3-4).

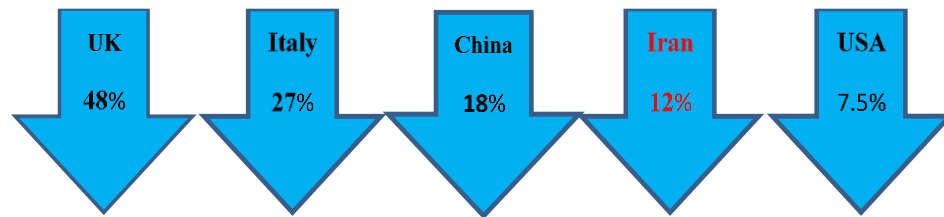


Fig. 3. Decrease in carbon emissions after COVID-19 lockdown (after Khan and Shah, 2021).

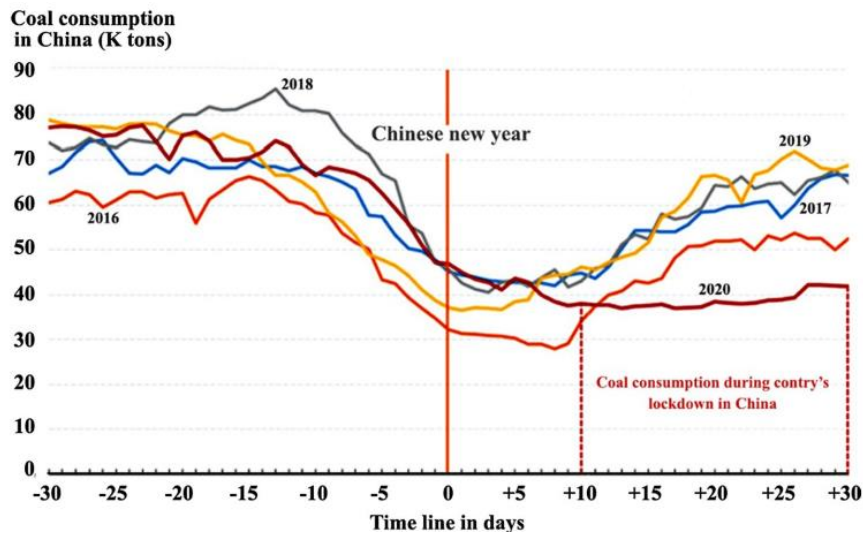


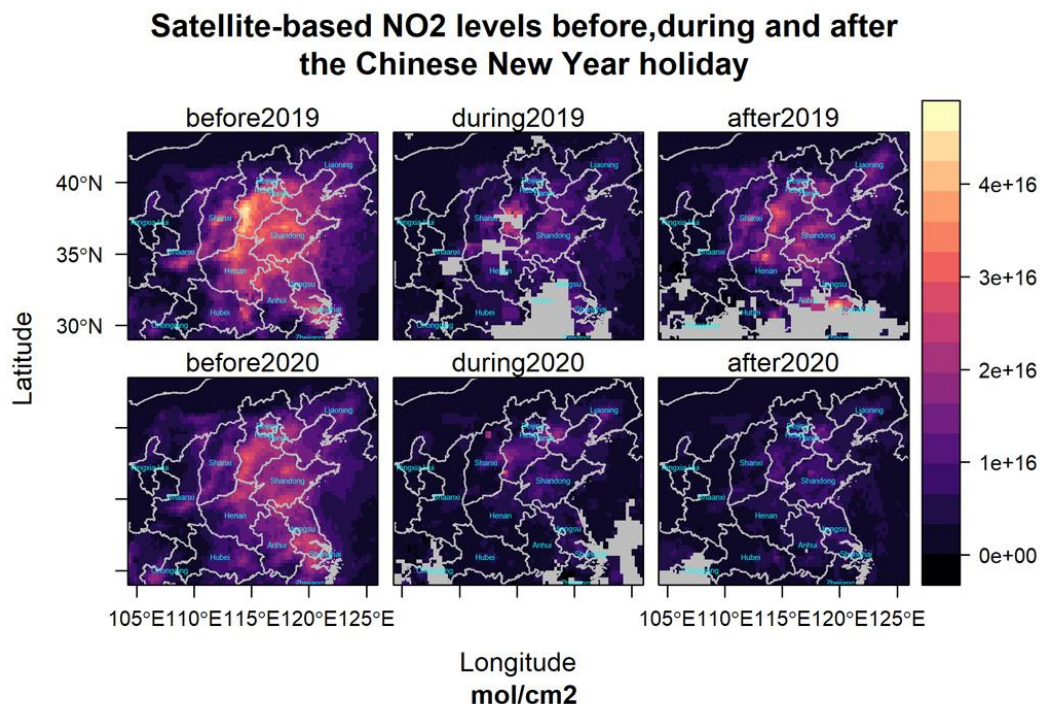
Fig. 4. Use of coal fuel in China in 2016–2020. The consumption drops for all years during the Chinese new year is explained by holidays with industrial shutdowns. In 2020 coal consumption is drastically reduced to 40 K tons during the lockdown, 10–30 days after the new year, versus about 80 K tons before the COVID episode (Mousazadeh et al., 2020).

### 3.2.3. Decreasing in air pollution

Air pollution is a serious health risk. Over 90% of the global population lives in places where the WHO outdoor air quality guideline levels are not met, and about two-thirds of this exposure is caused by burning of fossil fuels. Efforts to control COVID-19 transmission have reduced economic activity and led to temporary improvements in air quality in some areas. One of the main positive impacts of the COVID-19 outbreak is a significant drop in the air pollution and appeared blue sky which has been reported in many parts of the world such as Iran, China and Italy (NASA, 2020). Many countries around the world have implemented lockdown and quarantine to slow down the spread of the virus. Due to this, many flights have been cancelled and there are less vehicles on the streets meaning a lot less air pollution and greenhouse gases being emitted. Thus the air quality has been improved significantly. For example, in the first month of lockdowns

and quarantines, the reduction in air traffic, oil refining, coal consumption, resulted in a 25 percent reduction of carbon emission in China. Also, China produced approximately 200 million metric tons of carbon dioxide less than the same period in 2019. Earth systems scientist estimated that this reduction of air pollution may have saved at least 77,000 lives (UNEP, 2021). Use of coal fuel in China in 2016–2020 has dropped for all years during the Chinese new year. This is explained by holidays with industrial shutdowns. In 2020 coal consumption is drastically reduced to 40 K tons during the lockdown, 10–30 days after the new year, versus about 80 K tons before the COVID-19 episode (Mousazadeh et al., 2020). Also, according to NASA scientists, the drop in  $\text{NO}_2$  pollution began in Wuhan, China and slowly spread to the rest of the world (Fig. 5).

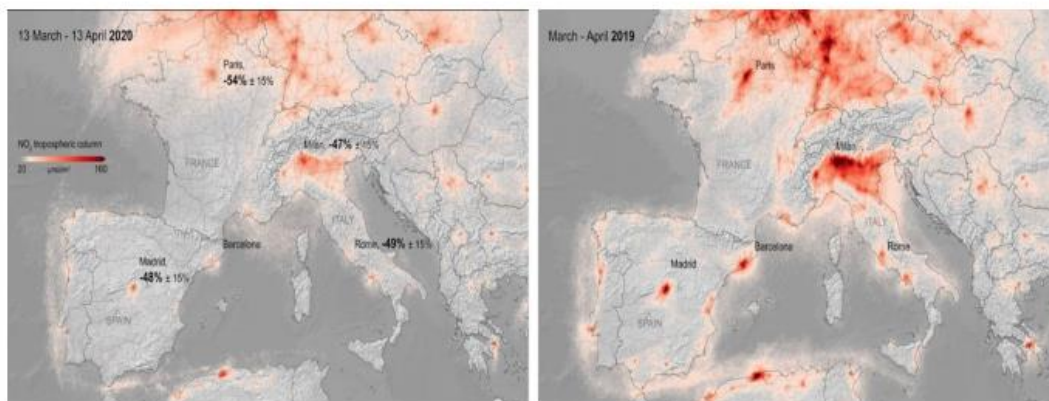




**Fig. 5.** Average atmospheric levels of NO<sub>2</sub> (molecules per centimeter squared) measured by the NASA OMI instrument (NASA, 2020).

Another example is Italy, which is the most infected country in Europe. The European Space Agency's Sentinel-5 satellite shows that air pollution levels, especially nitrogen dioxide gas compounds, have dropped across Italy. Between 1 January and 11 March 2020, the European Space Agency observed a marked decline in nitrous oxide emissions from cars, power plants, and factories in the Po Valley region in northern Italy, coinciding with lockdowns in the region (Green, 2020). That's probably why a quarter or more of the country's carbon dioxide emissions have been eliminated (Conticini et al., 2020). Also, the

average level of nitrogen dioxide, which is closely related to fossil fuel consumption, was 36 percent lower this week than in the same period last year. The data show such reduction not only in Italy but also in other parts of European countries. The average concentrations of NO<sub>2</sub> from 13 March till 13 April 2020, compared to March–April, 2019 show significantly reduction over Europe (Fig.6). Also, the concentration of ozone in March 12, 2019 comparison with March 12, 2020 show significantly reduction over Arctic regions (Fig. 7).



**Fig. 6.** The concentrations of nitrogen dioxide over Europe from 13 March till 13 April 2020, compared to the average concentrations from March–April, 2019 (Khan and Shah, 2021).

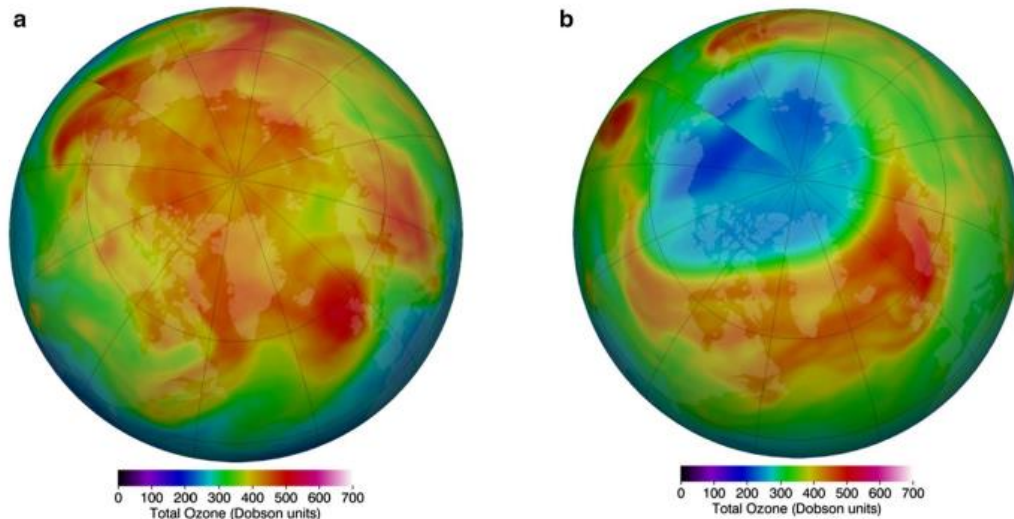


Fig. 7. The concentration of ozone over Arctic regions in March 12, 2019, a) in comparison with March 12, 2020, b) (Khan and Shah, 2021)

Iran is the most infected country in the Middle East. The decline in industrial activity, ban on travel, home and social quarantines, and the restriction of traffic lowered air pollution levels in some cities and regions of the Iran (MHME, 2021). Fuel consumption and carbon emissions in Iran has been significantly decreased by about 20% and 12% (MHME, 2021). Tehran is the most crowded and polluted city of Iran. The air pollution in the city is related to cars (61%) and resident sources such as home and industrial (39%). As a result of the decline in industrial activity, the ban on travel, home and social quarantines, the restriction of traffic, the air cleared fairly in the city which has not been seen before during the last 10 years (Fig. 8). According to Iranian calendar, the first day of spring (March, 21) is known as the Persian New Year (so called Nowruz). The country is in full holidays for 5 days (21-26 March) and peoples travel a lot. The data show that fuel consumption during 21-26 March of 2019 was about 100 million liters per day. The fuel consumption has decreased to 46.6 million liters per day during 21-26 March of 2020. The comparison of the data to that of the same period last year shows that gasoline consumption has decreased by about 46.5% (IRNA, 2021). This amount of decrease in the gasoline consumption has the main role in reduction of air pollution in Iran. The amount of decrease in the fuel consumption for March of 2021 is about 30% (IRNA, 2021). New research show that the changes in climate pollutants and other air

pollutants during the COVID-19 pandemic in Tehran is short-lived in different periods of COVID-19 patients increases. The data confirms that concentrations of pollutants increased during the first lockdown period; when the number of COVID-19 patients increased sharply compared to the other periods, the mean surface concentrations of  $\text{NO}_2$ ,  $\text{SO}_2$ , and  $\text{CO}$  were decreased and concentrations of other pollutants (i.e.,  $\text{O}_3$ ,  $\text{PM}_{10}$ , and  $\text{PM}_{2.5}$ ) were increased during the second lockdown period compared to the corresponding period in 2019. In the third period, the mean concentrations were decreased compared to the corresponding period in 2019 (Tehran Air Quality Control Company, 2020). For the full period, decreases in mean concentrations of  $\text{O}_3$ ,  $\text{NO}_2$ ,  $\text{SO}_2$ ,  $\text{CO}$ , and  $\text{PM}_{10}$  and increases in  $\text{PM}_{2.5}$  were observed during the COVID-19 crisis, compared to 2019. Overall, the strongest reductions, 12% and 6%, respectively, were observed for  $\text{CO}$  and  $\text{NO}_2$ , pointing to reduced emissions from traffic as a result of lockdown measures. The concentrations of other pollutants changed little, suggesting that the lockdown measures did not result in strong changes in the emissions from stationary sources (Borhani et al., 2021). In summary, the changes in air quality in 2020-2021 compared to 2019 were quite modest. There were clear reductions in average  $\text{O}_3$ ,  $\text{NO}_2$ ,  $\text{SO}_2$ ,  $\text{CO}$ , and  $\text{PM}_{10}$  concentrations in Tehran (Broomandi et al., 2020).





**Fig. 8.** The reduction in motor vehicle traffic has led to a drop in air pollution levels. Moddares highway in center of Tehran, Iran, on 25 March, 2020 (IRNA, 2021).

#### 3.2.4. Reduced pressure on natural resources

The reduced pressure on natural resources, decrease in air pollution and climate change, reduction in accidents up to 60%, life style change (50% reduced consumption of red meat), increase in distance paperless education and business activities, deeper understanding of the ecosystems and environmental savings are the significant positive environmental impacts (Amazonaws, 2021). To combat COVID-19, companies have asked workers to work from home. This has reduced vehicles on roads and fuel consumption. In addition to these, the consumption of paper, plastic and other natural resources has also reduced by people. One of the most important case is reduction in paper use, print less and direct shop less. Implementing paperless methods allows us to significantly reduce paper uses. It means that paperless and digital processes around the world are not only helping our ecosystem, environment and saving forests, trees and other vegetation, but also save our health and safety. Also, using less paper may be a way to help stop indirectly from spreading the virus. The widespread use of online education, meetings, online shopping and commerce led to a decline in paper consumption. Paper waste is a big issue in business and education centers such as universities and schools. It makes up the largest part of non-recycled waste that offices, universities and schools generate. Also, chemical components used in paper manufacture, such as dyes, inks, bleach and sizing, can be detrimental to our ecosystem and environment when released into water supplies. COVID-19 is changing how employees work and how offices are laid out.

There are many ways to communicate digitally, including email, instant messaging platforms, text message, electronic calendars, and project management systems. These communication systems make for an easier way of chatting remotely and for referencing written information in the future. The need for paperless office practices has grown significant as a result of the COVID-19 pandemic. A new survey of more than 2,375 business leaders and employees by FOXIT Software found companies have dramatically increased their use of paperless business processes and related digital solutions during the pandemic. More than 67% say their company's need for paperless office processes has increased during the pandemic. The report finds 55% of US employees say they would like to work from home more often, even after the pandemic ends. And it finds that leaders need to consider overall employee feelings about vaccinations when planning their return-to-office strategies (FOXIT, 2021). Another unexpected effect on the environment from the COVID-19 has been seen in Venice, Italy (Srikanth, 2020). The water in the canals cleared and experienced an increased presence of fish and waterfowl. The increase in water clarity was due to the settling of sediment that is disturbed by boat traffic and mentioned the decrease in air pollution along the waterways (NASA, 2020). In Iran, many educational, business, scientific and family meeting are taking place online. This has forced the country to build both data capacity and new application technologies such as native applications. If this is managed properly, after the end of the COVID-19 crisis, there will be a tremendous and extraordinary opportunity for the country to expand paperless trade and education. The

paperless world led to save many forests and other vegetation for the ecosystem and environment of Iran which is too poor for forest and vegetation.

### 3.3. Ecosystem results

The COVID-19 is resulted by human interaction in the ecosystems and environment. In recent decades, zoonotic diseases (75%) have gained international attention such as Ebola, bird flu, swine flu, MERS, SARS,... and now, the COVID-19. It is clear that these zoonotic diseases are closely interlinked with the health of ecosystems and environment (WHO, 2020).

In the last century, a combination of population growth and human activities have resulted in major changes in the ecosystems and environment such as greenhouse gas emissions, global warming and Climate change. Human and animal populations are increasing migration, urbanization, changing dietary preferences, trade demands, and travel. This has led to the expansion of cropland and more intense livestock farming near and around cities, increasing opportunities for exposure.

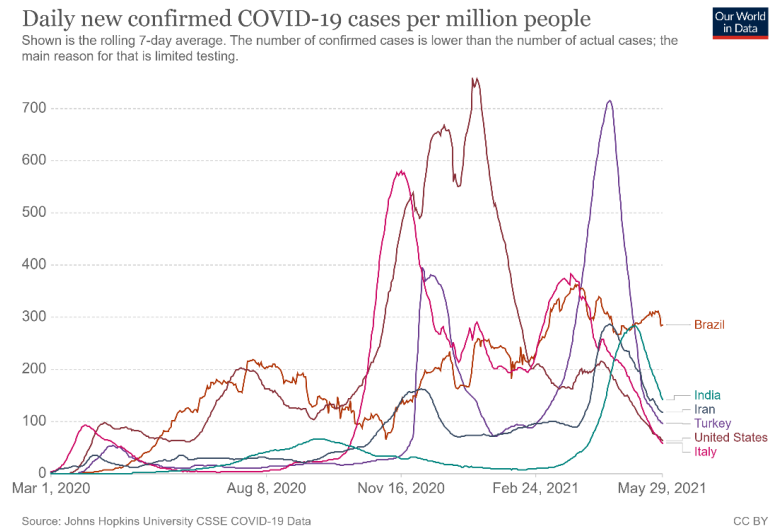
Livestock often serve as an epidemiological bridge between wildlife and human infections (UNEP, 2021). One major and predominately positive benefit of the pandemic for wildlife is less human travel.

Due to the significant reduction in journeys and digital transformation, fewer people are hitting and injuring or killing wildlife on roadways and help accelerate recovery of our ecosystem. The data show that roadkill rates fell by more than 40% during the first few weeks of the pandemic restrictions in 11 European countries such as Spain. From March 2021 found that hedgehog roadkill rates in Poland were more than 50% lower compared with pre-pandemic years, saving tens of thousands of hedgehogs in Poland alone. In addition, fewer ships are traveling through the world's waterways and oceans for shipping, fishing, aquaculture, and tourism purposes. A reduction in water travel and activity could

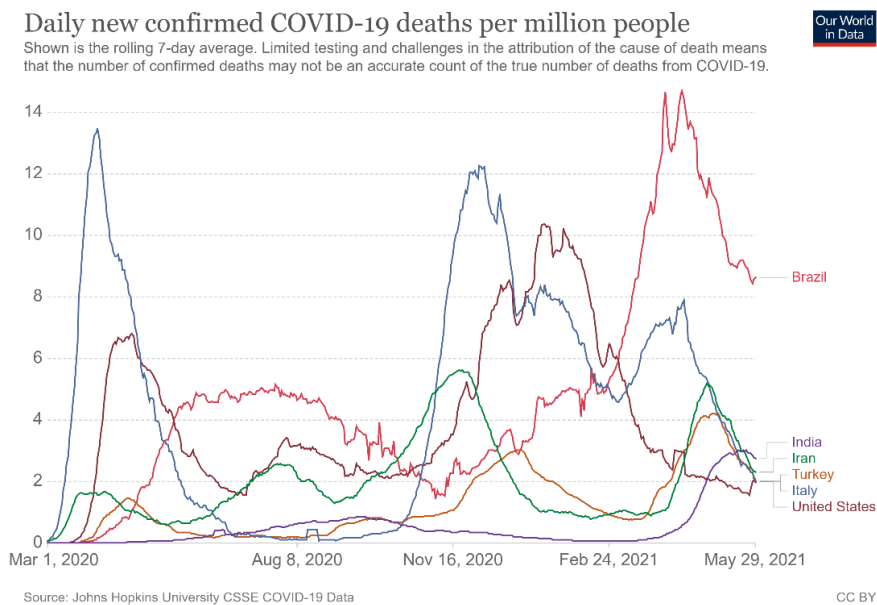
reduce the risk of ships striking and injuring or killing marine animals. It may also reduce the marine disruption that occurs due to noise pollution from ships, fishing sonar, and recreational boats. Also, lower fishing demand and activity may reduce the removal of animals from the wild. Birds might also be benefitting from the sharp decline in air travel, which may have vastly reduced the risk of bird strikes (Medical news today, 2021). The COVID-19 spread to Iran on 19 February 2020. In the short time since the COVID-19 crisis began, several impacts have been reported in the human and natural environment of Iran (Yazdi, 2020). The impacts are similar to that reported in other parts of the world. Lower fuel consumption, significant reduction in journeys and significant increasing in digital business and education help accelerate recovery of Iran's ecosystem such as other parts of the world.

On the contrary, human infection and death, economic failure, increasing in household consumption, medicine, faces masks and medical gloves, drinking water (up to 30%) and challenge in burial of household and medical waste are the significant negative environmental and ecosystem impacts.

The virus has resulted more than 2.6 million infections and 73,300 deaths, at the time of writing of the paper (as of 10<sup>th</sup> May, 2021). In response to the crisis, the government cancelled public events such as Friday prayers, festival celebrations, sporting events, including football matches and closed schools, universities, shopping centers, bazaars, and even holy shrines (Wright, 2021). The *Ministry of Health* and Medical Education (MOHME) data show that the share of each place in the COVID-19 infections is: schools=12%, universities=6%, offices= 3.5%, Friday prayers= 0.02%, holy shrines= 0.04%, public transport= 26% and stores and small business= 22%. But they banned celebration in even Friday prayers and holy shrines to control spreading of this virus. Now, Iran has been experienced several peak (4 major peaks) of infection spreads and deaths (Figs. 9-10).



**Fig. 9.** Decline in new cases of Covid-19 in Iran and other several countries (World data, 2021).



**Fig. 10.** Decline in daily deaths of Covid-19 in Iran and other several countries (World data, 2021).

### 3.4. Climate types and infection rate

Since December 2019, COVID-19 disease has been spread rapidly in all regions of the world, from cold and dry, to hot and humid climates. It was supposed that COVID-19 display seasonal patterns such as other infectious diseases. Because environmental factors such as temperature and humidity play an important role in progression and spread of infectious diseases infection. After one year, there is no evidence of direct connection between environmental issue, geography, climate change and transmission of COVID-19 disease. However, environmental issue, geography, climate change indirectly affects the COVID-19 response, health systems and

additional stress to disease. Geographical patterns of transmission depend on many other factors like physical property of the virus, outdoor and indoor environments, population densities, hygiene, space, and genetic predispositions (MHME, 2021). There is an abundance of ideas that the rising of global temperatures and climate change is the cause of the COVID-19 spreading. Climate change leads to a lot of changes in vegetation, in animal behavior, in human behavior, and these may cause diseases to spread geographically, and diseases being able to infect new animal species. Although, we were worsening the climate crisis by destroying biodiversity, natural habitats and facilitate the emergence and spread of these new diseases.

There is correlation between air pollution and the number of deaths from COVID-19. The researchers suggest that air pollution and relatively older populations is another possible factor that could explain this variation (Green, 2020). Iran is one of the countries with different types of climate. The seasonality and dynamics of COVID-19 are not well understood in Iran such as other parts of the world. During the last year most affected areas are in northern parts of Iran. The areas are wet and rainy, touristic and too populated. The infection rate in other provinces is different. The research on the basis of number of infected people, population density, intra-provincial movement, days of infection, average temperature, average rain, humidity, wind speed, and solar radiation with infection rate show that the population density, intra-

provincial movement, day of infection have a direct relation with infection outbreak. The effective parameters in the COVID-19 outbreak show that Tehran, Sari, Rasht, and Qom people are more infected because of the high population and intra-provincial movement (Figs. 11-12). Conversely, wind speed, humidity, and solar radiation have an indirect correlation with the infection rate. However, in two humid regions of Iran, the rate of virus spreading is high. Consequently, based on the geographical maps, the average rate of disease spread in humid provinces is higher than in other areas of Iran, however in arid areas humidity has a reverse relationship with the disease infection rate; the central provinces of Iran are approximately higher than in marginal and southern regions (MHME, 2021).

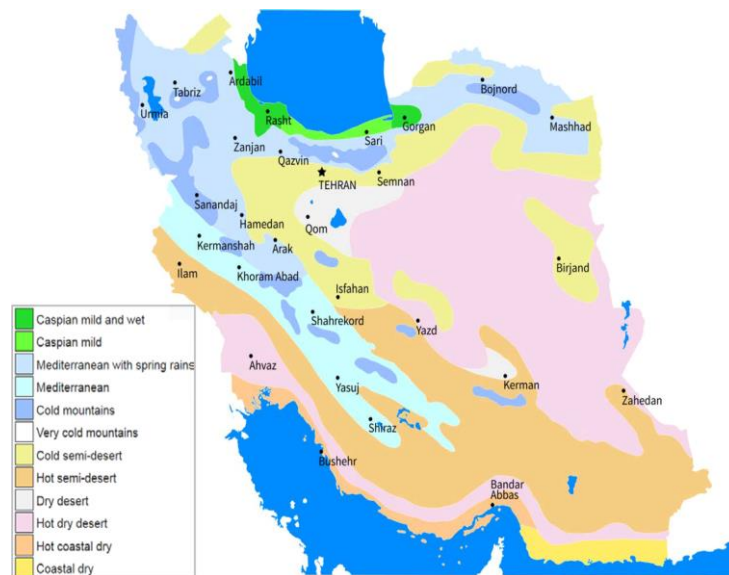


Fig. 11. Climate map of Iran showing the location of province capitals (Ashraf Vaghefi et al., 2019)



Fig. 12. COVID-19 rate in Iran by provinces (MHME, 2021)



## 4. Conclusion

COVID-19 crisis demonstrates the close relationships between human, animal, ecosystems and environment. The COVID-19 will not only affect the human environment, but also our ecosystem and natural environment. Many environmentalists are happy that the COVID-19 has caused positive changes in the ecosystems and environment, especially reduced pressure on natural resources, lower energy consumption, decrease in air pollution and climate change, reduction in accidents, life style changes, increase in distance education and paperless business activities, deeper understanding of the ecosystems and environment. It means that saving more forests, trees and other vegetation and lower production of paper wastes. Despite a temporary decline in global carbon emissions due to the lockdown and quarantine, reduction in air traffic, oil refining, and coal consumption, the decrease in emissions seem to be short-lived. After the end of this crisis, countries would attempt to return to previous rates of economic growth and would supply chain disruptions in the energy that will worsen its environmental impact. If we don't take care of our ecosystems and environment, it is clear that COVID-19 will not be the last pandemic. Because the ecosystems and environment destruction are directly affected by the spread of pandemic diseases such as COVID-19. Since December 2019, COVID-19 disease has been spread rapidly in all regions of the world as well as Iran.

It was supposed that this disease displays seasonal patterns such as other infectious diseases but the data show that it spreads in all climates from cold and dry, to hot and humid. The data show that people in Tehran, Sari, Rasht, and Qom cities are more infected because of the high population and intra-provincial movement, and not the climates conditions. Some reports showed that a small increase in long-term exposure to particulate matter (PM<sub>2.5</sub>) and air pollution leads to a large increase in death rate in the more polluted cities such as Tehran. Lower fuel consumption, significant reduction in journeys and significant increasing in digital business and education help accelerate recovery of Iran's ecosystem such as other parts of the world. On the contrary, human infection and death, economic failure, increase in household consumption, medicine, faces masks and medical gloves, drinking water (up to 30%) and challenge in burial of household and medical waste are the significant negative environmental and ecosystem impacts.

### Availability of data and materials

The datasets used in this research are available from the corresponding author on reasonable request.

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