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COVID-19 Outbreak: Impacts on Environment and Food Security

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Abstract: The pandemic novel coronavirus disease-19 (COVID-19) is surmise to be one of the major transformative events of the 21st century in human-history. The outbreak of the highly infectious disease COVID-19 exploded lethal storm on trend of human civilization. Despite it impacts on several issues, we reviewed the positive and negative influence of severe acute respiratory syndrome coronavirus 2 outbreaks on environment and agriculture at global scales, based on published articles, WHO bulletins, guidelines, books, reports, worldometer including government documents and conference papers. However, the exact severity and networks of its consequences is unpredictable. A clear improvement in air quality has been observed as a boon in the environment. Energy consumption and carbon emission has been reduced. Thus, the ozone layer has been maintained at the expected level. However, on the flip side, disruption of assessment, temporary closure of educational institutions, inequalities and students drop-out is the serious concern resulting from COVID-19. In the environment, the medical and food wastes, plastic packaging has been added. Many agro-processing industries have been severely halted. Moreover, the global economic activities have been crippling which is raising the issues of food security, increased unemployment at national and global scales. Furthermore, it has increased the health crisis and worsens human development index and economy in present decades, consequently increasing environment and food security threats. Thus, this study aim to improve the better understanding of how pandemic influences on environment and agriculture issue of global perspectives. It provides wide ideas to government, social practitioners, and policymakers to improve outbreak preparedness and response plan to any kind of biological outbreaks and pandemic crisis.

Keywords: COVID-19; impact; environment; agriculture, food security

Introduction

At the end of December 2019, the novel coronavirus disease-19 (COVID-19) was erupted in Wuhan, the capital city of the Hubei province of the People's Republic of China. However, according to the South China Morning Post, the first confirmed case of COVID-19 traced backed to November 17, 2019, in a Hubei resident aged 55 [1]. The novel coronavirus disease caused by a newly discovered severe acute respiratory coronavirus 2 (SARS-Cov-2) is highly infectious and spread rapidly *via* droplet and aerosol of infected persons [2]. At present the outbreak has spread across the world over 213 countries and territories. According to the World Health Organization (WHO), a total number of 31,505,063 confirmed cases and the death toll 969,771 have been reported as of September 22, 2020 with a fatality rate of ~3.81 % within the seven months. The 2019 novel coronavirus (2019-nCoV) is known to be novel and highly similar (>75% sequence) to the previously known SARS, SARS-CoV-1 of 2003, and Middle East Respiratory Syndrome (MERS) starting in 2012 [3]. The only way to control the transmission is break down of the human-human transmission chain through maintaining social distance, quarantine, adequate testing, aggressive contact tracing, isolating and lockdown. Among these tools, lockdown is not an end of curbing the COVID-19; it is a means to advancing the rest of the things including the health care system. Thus as a first measures, the governments have declared lockdown across the world. Consequently, it imposed restriction at the moment, closure of schools universities, recreational facilities and places of worship, shut down of industries, and travel restriction [4]. This is the most terrorizing and devastating catastrophe pandemic that not only disrupted the health and health care system but also beyond including economic crisis and the actual severity of its impact is yet to be predicted. COVID-19 pandemic has caused huge negative and few

positive impacts on education, environment, agriculture and national security.

The impact of COVID-19 is not limited to human infection and death; other associated issues should be addressed. The COVID-19 has spread globally, shrinks the bases of economy and employment, constraining the billions of population into lockdown, and endangering global human security, i.e., the security of life, liberty, and happiness. Consequently, within a very short period, it has been overwhelmingly reshaping our lives, causing tremendous human suffering and challenging the most basic foundations of societal well-being [5]. COVID-19 is an alarming to human civilization and the environment. The severity is mainly increasing in low-income countries where inadequate health care systems and facilities are scarce and limited [6]. WHO-China Joint Mission with the presence of experts representing various countries has stipulated five recommendations on February 24 to be used to curb the epidemic that includes strengthening national response management, community education, contact tracing, isolation and surveillance enhancement [7]. Contact tracing, isolation, surveillance, social distancing, lockdown, and shut down approaches have been adopted in national, regional, and local scale to keep safe for the people. Early detection, contact tracing, isolation of suspected individuals only are not enough to curb with COVID-19 pandemic. Country guidelines and public efforts such as proper cough etiquette, regular hand washing, and physical distancing should be practiced and integrated [8].Besides the human loss, the pandemic has several environmental influences during the lockdown/shut down period. The air pollution i.e. emission of CO_2, black carbon, NO_2, and particulates matter, increased ozone have reduced due to low traffic, less energy consumption, and poor industrial operation [9-11].

Worldwide around 1.3 billion smallholders and landless workers involve in agriculture for their livelihoods. About 80% of the world's food is produced on family farm [12]. Agriculture has unique contribution in human, animal, flora, fauna, microorganism and plant lives, and world economic development, industrialization, infrastructure development, make up friendly environment, maintenance of sound ecology, micro and macro organisms adaptation, allopathic, homeopathic and herbal medicine production, food security and poverty reduction etc [13-15]. Due to COVID19 becoming as pandemic, all these sectors have been devastatingly affected, and still are on the standing of huge losses. Various stakeholders from different domain such as policy makers, scientists, researchers and government bodies over the world are concerned about deleterious effects of COVID19, and its mitigation and remedy. In agriculture sectors, their main headache on crop, livestock, fisheries and forest production and their transport, processing, packaging, marketing and consumption [16]. Globalization refers to the free trade, free flow of capital, technologies, skills, ideas, etc., from one place to another. The growing impacts of globalization, marketing, technological advancement and interdependency are shaping planet and prosperity. It is a process (or a set of the process) of transformation among spatial organization of social relations and transactions, generating intercontinental or international flows and network of activities, interaction, and power [17]. The outbreak of infectious disease, epidemic, and pandemic, can create a serious threat to national security [18] and global security [19]. This review article discusses the impacts of both during and post-COVID-19 influences of severe acute respiratory syndrome coronavirus 2 (SARS-COV-2) outbreak to provide a better understanding to government, practitioners, and policymakers to improve and the management of response to infectious disease outbreaks which are critical for a country's environment and food security in the global community.

Study area and method

The coverage of this review article is worldwide. We reviewed the positive and negative influence of severe acute respiratory syndrome coronavirus 2 outbreaks on environment and agriculture at global scales, based on published articles, WHO bulletins, guidelines, books, reports, worldometer and Real-time Air Quality Index (WAQI) (www.aqicn.org) including government documents and conference papers. The review was also followed the online questionnaire survey conducted for ten countries from May 11, 2020 to May 31, 2020. The survey regarding the amount of air pollution before and during restrictions have done among 9394 respondents of 10 countries (such as Australia, Brazil, China, Ghana, India, Iran, Italy, Norway, South Africa

and United State of America) through goggle form using professional and social networks (Barbieri et al, 2020). The positive and negative influences of COVID-19 were parameterized as physical, biological and socioeconomic environments based on global watch experience and daily update from live records and institutional reporting.

Results and Discussion

Impacts of COVID-19 on Environment

With this current pandemic, air quality has been improved globally. In many countries, movement restriction has led to reduced traffic resulting in reduced environmental pollution. Improved air quality status is not only good for the environment and people; it controls the spreading of viruses. Pollutant air would increase the spread of the virus through fine particles [20]. Air pollution governed to the spreading of virus droplets released from sneezing or coughing of the people. Thus, cleaning air pollution automatically reduced the transmission of the virus [21]. Air pollution mainly NO2 in major cities of China has been observed reduced during this period [22]. NO_2 is an ill-famed gas which is emitted through the burning process of petro-chemicals such as coal, oil, diesel and gases in vehicles, industries and power plants. The NO_2 can form the ozone near at the troposphere which makes air unhealthy and hazy. It can also form acid rain in the higher atmosphere. Thus, the reduction of NO_2 during lockdown will have good environmental benefits. The air traffic and the entire aviation industry are most affected by COVID-19 [23]. Airports are the major spot for NO_2 production which is released from the burning of fuels either from airplanes or cars. Excessive uses of fuel by airplanes also exhaust formaldehyde which is an indicator of ozone formation. Ozone in the troposphere increases chest pain, coughing, and throat irritation. At the same time, economic crises and a large mass of unemployment increase food insecurity mainly in developing countries. Increased import, export, and supply chain disruption create uncertainty in agricultural markets. During this period, different medicine and disinfectants are used in hospitals, clinics, shops, and private homes [21] which may have impacts on both humans and the environment. The overall possible positive and negative environmental consequences of COVID-19 pandemic are summarized in Figure 1. Globally, the corona crisis may increase poverty. It is very difficult to meet the target of the agenda for sustainable development. Poverty eradication target of SDGs by 2030 can be impacted by COVID-19 pandemic in large scales. COVID-19 can also reshape the environment policies at national and international scales.

The outbreak of SARS-CoV-2 pressurizes worldwide for the temporary closure of schools, colleges, universities and other academic institution, a consequence of the different degree of lockdown, social distancing and quarantine [4], impacting over 80% of the world's student population [24]. Ultimately, the schools and universities have no option to start teaching and learning procedure *via* different online approaches, as practical tools in the global situation of academic doom [25-26]. However, several challenges aroused, for instances, limited access to the internet, and no electricity in the rural regions, monitoring quality assurance mechanisms and quality benchmark for online learning, the insufficient fund for a poor family to buy electronic gadgets to implement e-learning techniques [27-28]. As a result, only selective private schools could adopt online teaching methods but low-income private and government school counterparts have completely shut down e-learning solutions [29]. This disproportionate e-learning platforms and e-resources increased the gaps between several advantaged and marginalized students group [30]. However, it will be too early to predict the magnitude of the educational landscape after COVID-19 comes to end [31].

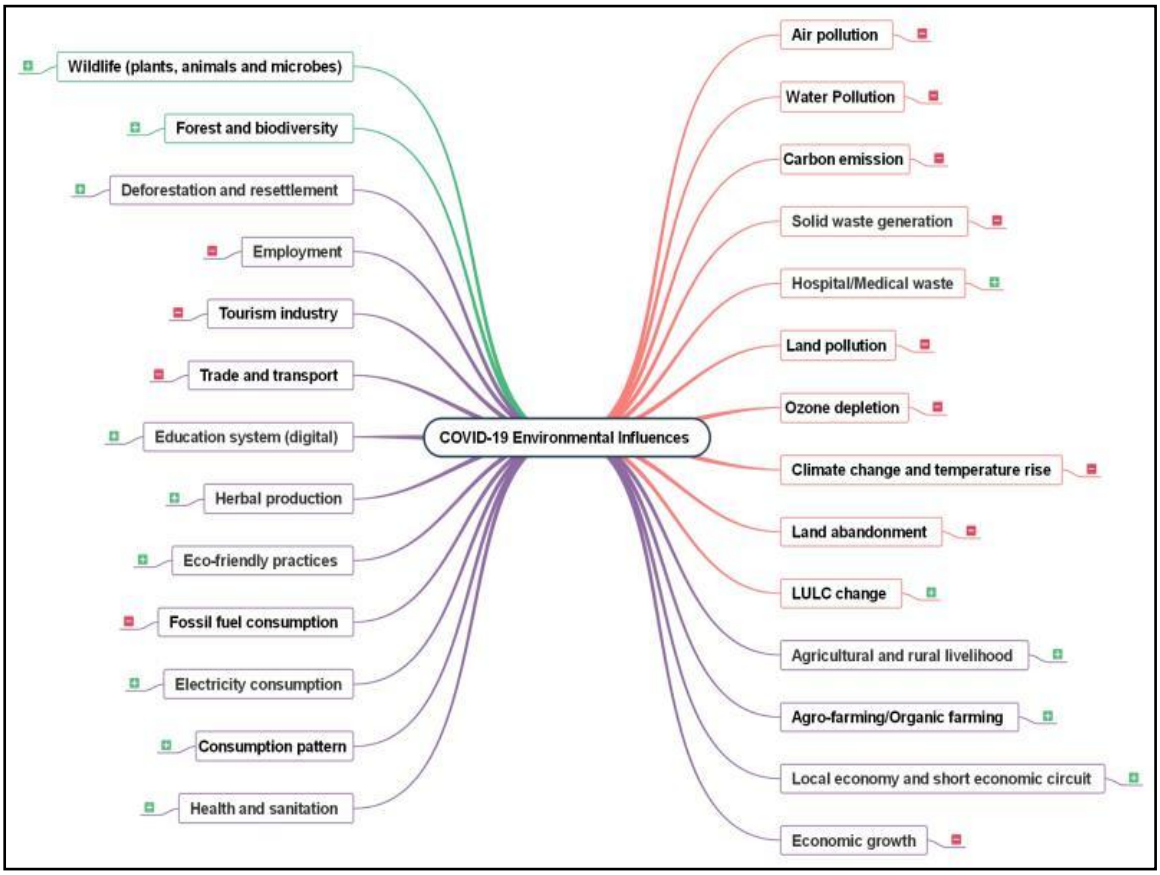

Figure 1 Observed COVID-19 environmental influences on environment (red, green and purple color indicates physical, biological, and socio-economic environmental parameters, respectively; + sign indicate increased and – sign indicate decreased)

The pollution load is reduced except for some medical waste, plastics and PPE discharged. The social behaviors, international trade and practices, and new policies might affect the socio-economic environment during both lockdowns and post COVID-19 periods. The employment is decreased and the biological environment will be affected (Figure 1). Change in the socio-ecological system improved regional climates, improved citizen wellness, and health protection; enhance planning for biological disaster (epidemics/pandemic) risk reduction is major post-COVID-19 environmental influences [32]. The ecological system related to plants, animals, microbes, and wildlife will get more attention. It is known that different series of coronavirus are zoonotic and the pandemic between wildlife markets. With taking lessons from this pandemic, people may start to make harmonic relations with animals and wildlife and respect all varieties of wildlife trade and treaties. The communities with open spaces, gardens, and separate housing systems, subsistence agriculture and less fuel consumption may lead to a healthy environment during post COVID livelihood practices. Household electricity consumption during lockdown has increased but fossil fuel consumption has decreased. Due to the low traffic volume, urban water quality remains less deteriorated. The coronavirus is detected in wastewater [33] which encourages the people to manage sewage network in the future. The presence of novel coronavirus in wastewater has positive and long-term environmental implications for proper management of the drainage network. Globally, industrial water consumption is decreased during the lockdown period. In Milan of Italy, the COVID-19 crisis has shifted car track to pedestrians and bicycles over 35 km of streets [34]. The practices can expand in several cities which will have long term urban environmental significance. Restricting international flight and border seal has led to the fall of 17.57% export revenues in Nepal [35]. Similarly, Japan has reduced 18% of car export to the international market during lockdown [36]. This recession economy led to a crisis and a larger impact on the social, political, and economic environment.

COVID-19 has immediate and long term environmental consequences. The socio-ecological

system will be variables in their individual lifestyles, community practices, and international relations [37]. In EU countries, energy consumption in industrial and transportation sectors is responsible to emits 54% of the volatile organic compounds, 51% of the NO_x, 30% of the $PM_{2.5}$, and 25% of SO_x to the atmosphere [9]. These emission trends are largely reduced by lockdown and closed industrial and transport sectors. In the long term, the socio-ecological system will be directed towards the green economy and resistive which may lead to sustainable development. The decreased NO_2 pollution has first been observed near Wuhan and spread across the world [38]. The PM concentration has also been reduced in different parts of the world. In South Korea, $PM_{2.5}$ was lower by 54%. Similarly, in Los Angele, clean air was recorded and pollutants were lowered by 31% [39]. In Barcelona, NO_2 and black carbon were approximately reduced by 50%, PM_{10} was lowered by 30% and O_3 concentrations have increased by 33–57% [40]. The ground stations based pollution records in 40 selected cities of 35 countries updated by Real-time Air Quality Index (WAQI) (www.aqicn.org) portal showed decreased $PM_{2.5}$, PM_{10}, O_3, SO_2, CO, and NO_2 in the atmosphere during lockdown periods. According to NASA satellite record, aerosols were decreased in India and Nepal after lockdown during 2020 (**Figure 2**).

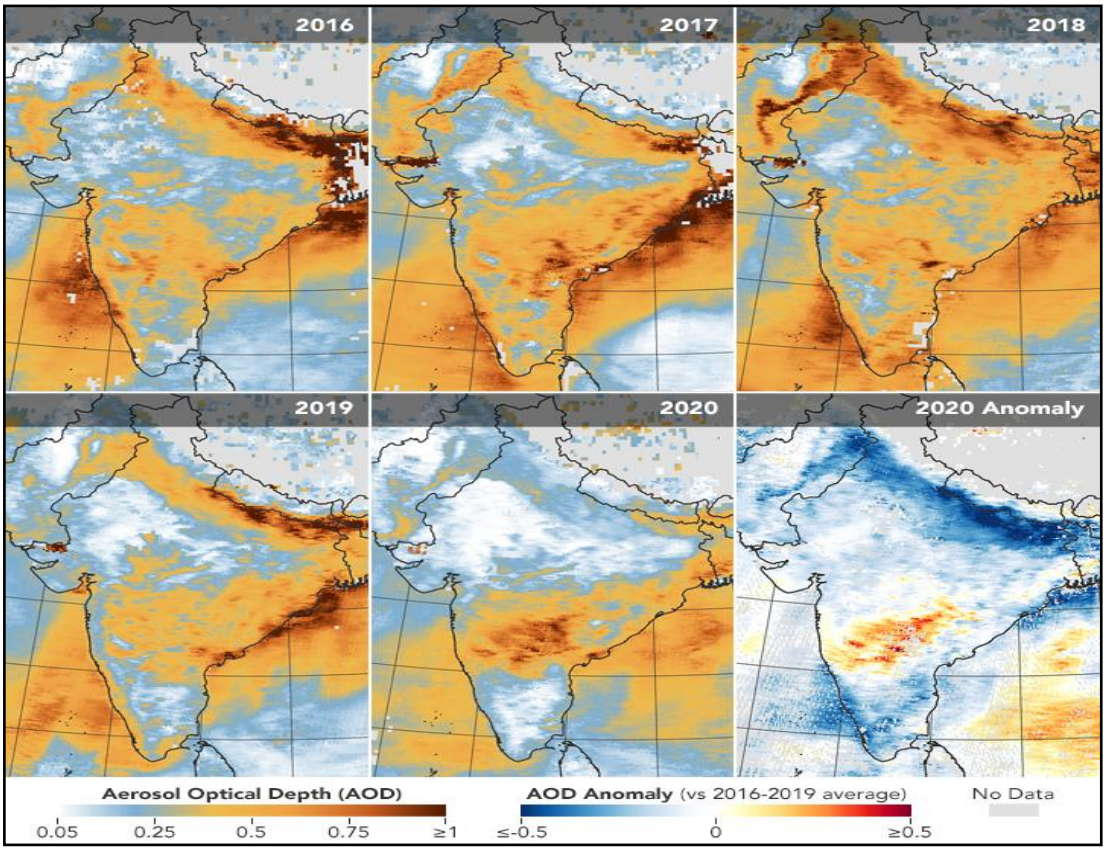

Figure 2 The variation of Aerosol Optical Depth covered India and Nepal from 2016 to 2020 and spatial-temporal anomaly of AOD in 2020; Source: NASA Earth observatory, 2020

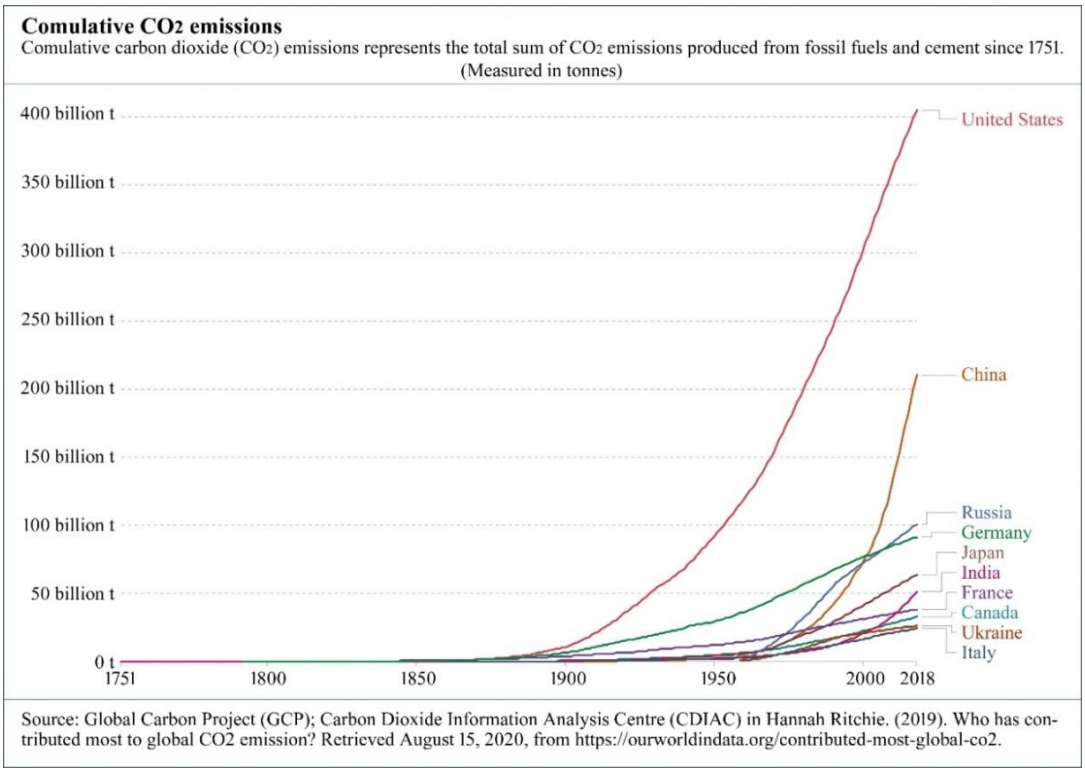

Figure 3: The top ten global contributors in CO_2 emission 1751 onward

As a consequence, daily global CO_2 emissions decreased by 17% during observation in early April 2020 compared with the mean 2019 levels [41] **(Figure 3).** Indeed, the spread of COVID-19 pandemic disease has dropped energy usage, trafficking, and industrial production that plummeted the carbon emission. Globally, relevant studies stated that air quality and water quality in rivers are improving and wildlife is flourishing after the outbreak of COVID-19 [42]. Though, the brief dips have had little lasting effects on climate change, as only systemic shifts have long-term impacts [43]. However, the impact on 2020 annual carbon emission would be determined by the duration of confinement, restriction on national and international transportation, and industrial activities across the world. Importantly, what measurements would be applied by the governments across the world regarding environmental protection would determine to post-pandemic carbon emission. Recently, the online questionnaire survey conducted for ten countries perceived improved air quality and the very high and extremely high categories of pollution in each country have perceived almost negligible during restriction (or lockdown) periods [44].

Impacts of COVID19 on agriculture and food security

Agriculture is the multidimensional and vast term. It includes crop farming, livestock husbandry, fisheries, forestry, apiculture, sericulture and agro-forestry. These sectors have been severely affected after COVID-19 became pandemic globally. The agricultural inputs producing mills and industries, such as fertilizer, pesticide, power tiller, tractor and harrow etc. have been near to close. Many agricultural produces processing mills and industries (rice mills, textile mills, dying producing mills, aromatic products and herbal medicine producing industries etc.) have been also in off position. Many workers are now unemployed. Crop, livestock, fish and forest production need intensive supervision, monitoring, advise and suggest to illiterate and poor farmers, and visit the farmers' home and field frequently. But, due to COVID-19 infection severity, the agricultural workers can't perform these important tasks properly. The farmers are also now very concern for the panic of corona virus infection. The immediate control measures of COVID-19 has limited people's access ability to healthy diet in various way, including through reduced income, increased job insecurity, and reduced the availability of diverse foods. Moreover, malnutrition has made the people susceptible to disease development. Thus, the agriculture food processing and marketing sectors are facing the problems of labor illness, related shortness,

transport and logistics supports and agricultural produces processing interruptions and quarantine measure making the limitation of access to markets, marketing and, buyer and merchandiser movement, and food supply reduced due to inability of its processing and marketing in addition to increased food loss and waste [45].

Impact of COVID19 on crop, livestock rearing and fish production

Crop production needs multiple inputs consisting of power tiller/tractor, labor, fertilizers, pesticides, insecticides, marketing channels and transport facilities etc. In the world, a lot of industries have been built up based on agricultural raw materials users and input suppliers. Many agricultural production inputs have to be imported through intercity transport and from foreign countries. Since, the COVID-19 is an infectious disease, all countries imposed the short and long term barriers on airport, seaport, transport, transit and all others communications system. So, crop production inputs and raw material processing products can't be moved from one place to another. It has been hampered, and agro-processing industries are on the door to close [46]. On the other hand, agricultural raw materials producers also export their products abroad. The chance of importing and exporting of agricultural products has been limited due to COVID-19 evolution. Many agricultural employees have been unemployed. Its negative effects has been imposed on the farmers family members, agricultural service providers, agro-industries' employees, transport and communication related employees etc. Due to limiting food production, the number of children (especially from poor and vulnerable family) suffering from malnutrition has been increased and the condition will be worsen if the pandemic continues [47]. Livestock is another important component of agriculture. It has the crucial economic roles for 60% of rural households in developing countries of the world. It contributes in the livelihood of 1.7 billion poor households, women employment and ensuring food security [48). Livestock play a vital role to meet up the multi-dimensional demands of the world people, such as meat (mainly it contains huge protein, vitamin and minerals etc), balanced diet (milk), baby food; in establishing agro-processing industries, leather industries, providing manure and power (traction power) in crop production, thus creating employment opportunities for the majority people. To rear cattle, cow, goat, sheep, camel, duck and chicken etc. need manpower, feeds, grasses, straws, medicines, transport and other logistics supports etc.COVID-19 has made vast obstacles to produce, transport and marketing of these inputs. Poultry and cattle feed producing industries can't continue their normal production activities due to shortage of feed raw materials, employee, the limitation of feed transportation, barriers of corona virus having guidelines of WHO to maintain social distance one meter far and labor working mind disheartened due to COVID-19 easily contamination and infection severity [49, 45]. Dairy, broiler and layer farms can't run smoothly for the above same reasons. Thus, COVID-19 has made the unemployment of many labors and staff in the field of livestock production, processing, preservation and marketing sectors.

Fish is an important sector of agriculture. Fisheries and aquaculture provide the livelihoods of almost 820 million people in the world [48]. More than a billion people consumed daily animal protein from fish. Moreover, fish provides nutrients to balance the healthy diet and child development [50]. Fish is the main source to meet up protein in many countries in the world. Many poor and vulnerable people of least and developing countries earn money from fish catching in natural water bodies (ponds, river, seas, channels etc.) and selling in the local *haat bazar*. The successful culture of modern fish and aquaculture depends on fish feed production, transport, marketing, processing and preservation, and availability of labor in the industries and transport sectors etc. After fishing from the ponds, rivers, seas and artificial water channels, fishes must be processed, dried, marketed, transported, stored, and preserved etc. Due to COVID-19's health warning systems, day labor, staff and officer working in the fish feed producing companies/industries have shortened. People can't work in any sector of fisheries and aquaculture by maintaining social distance, and avoid COVID-19 risks avoidance obligatory. Due to labor scarcity, limiting transport facilities, lack of raw materials of feed producing industries; many men and women have been unemployed. The countries involved in to fish products and fish feed export or imports have been faced loss to earn foreign money and are still on the situation.

In the world around 13 million people are employed in formal sector-related businesses. Again in the formal sector almost 41 million people are involved. Social forestry, agro-forestry, afforestation, reforestation and sustainable forest management create the employment opportunities for the village poor people. Many people are involved in timber processing, furniture preparation and color production industries etc. Transport needs to carry timbers, furniture and forest processing products from one place to another.

COVID-19 has restricted transport and labor movements. So, forest industries are facing various problems which are affecting negatively the livelihoods status of the world poor and rich people [45].

Recession of global economy and food problem

In the age of globalization, the economy is not only an engine of society; it is a lifeline of human civilizations, too, and economic activities drive the nation in many ways. However, global economic activities have been crippling due to the outbreak of the COVID-19. It collapses the global economy, threatens the prosperity of nation-states, and escalating social unrest and international tension across the world [51]. The global economic cost of COVID-19 is heavy; as the Asian Development Bank (ADB) projected it could between $ 5.8 trillion and $ 8.8 trillion [52]. Indeed, it is a failure of the advanced countries that they could not respond properly the new pandemic owing to lack of early eagerness and preparedness. The crisis highlights urgent requirement to protect and recovery for vulnerable populations [53] and food insecurity. The economic recession creates a chain-of-impacts in society across the world. For instance, unemployment and food insecurity is a consequence of the economic recession.

Conclusions

We have carefully reviewed the global influences of COVID-19 pandemic on environment and agriculture. Both positive and negative influences were investigated based on global scenarios, previous research, and available database. The physical, biological, and socio-economic environmental conditions have also been influenced by pandemic during the lockdown and post lockdown periods. Generally, air pollution has improved. Due to less consumption of fossil fuels and low traffic, the emission of NO_2, CO_2, and particulate matters has reduced in the atmosphere leading to improved air quality. COVID-19 pandemic has also some positive influence on agricultural growth, health, and sanitation but negative influences input, raw materials processing, transporting, marketing, exporting and importing between the places within the country and on abroad. It has made uncertain food security and poverty reduction taken the initiative by UNO as Sustainable development Goals. Failed to immediate control of COVID-19 will continue to worsen world food production and employment opportunity. Similarly, the COVID-19 pandemic primarily increases a health crisis and quickly became the worst human and economic crises which increase the national and global security threats. The COVID-19 pandemic is neither first nor last infectious disease against human civilization. There is a high probability of the eruption of the novel infectious disease in the future too, due to massive extraction and exploitation of nature including wildlife. Therefore, the advanced countries need to learn a great lesson from it regarding the crisis management and mechanism need to be adopted based on global cooperation to live and let live.

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References

1. China's first confirmed Covid-19 case traced back to November. Available online. https://www.scmp.com/news/china/society/article/3074991/coronavirus-chinas-first-confirmed-COVID-19-case-traced-back?onboard=true (Accessed on 28 August 2020).
2. COVID-19 coronavirus pandemic. Available online: https://www.worldometers.info/coronavirus/ (Accessed on 28 August 2020).
3. Li, H.; Liu, S.M.; Yu, X.H.; Tang, S.L; Tang, C.K. Coronavirus disease 2019 (COVID-19): current status and future perspectives. *Int. J. Antimicrob. Agents*, **2020**, *55*, 105951.
4. Sahu P. Closure of Universities Due to Coronavirus Disease 2019 (COVID-19): Impact on Education and Mental Health of Students and Academic Staff. *Cureus*, **2020**, *12*, e7541.

5. COVID- 19: Protecting people and societies. Available online. https://www.oecd.org/coronavirus/policy-responses/covid-19-protecting-people-and-societies-e5c9de1a/ (Accessed on 28 August 2020).
6. Panthee, B.; Dhungana, S.; Panthee, N.; Paudel, A.; Gyawali, S.; Panthee, S. COVID-19: the current situation in Nepal. *New Microbes and New Infect.*, **2020**, 37,100737.
7. Report of the WHO-China joint mission of coronavirus disease 2019 (COVID-19). Available online: https://www.who.int/publications/i/item/report-of-the-who-china-joint-missiononcoronavirus-disease-2019-(COVID-19) (Accessed on 28 August 2020).
8. COVID-19 Strategy update. Available online: https://www.who.int/publications/i/item/covid-19-strategy-update-14-april-2020 (Accessed on 28 August 2020).
9. Emissions of the main air pollutants in Europe. Available online: https://www.eea.europa.eu/data-and-maps/indicators/main-anthropogenic-air-pollutant-emissions/assessment-6 (Accessed on 28 August 2020).
10. Environmental Effects of Coronavirus Quarantines. Available online: https://earthobservatory.nasa.gov/images/event/146381/environmental-effects-of-coronavirus-quarantines (Accessed on 28 August 2020).
11. Tobías, A.; Carnerero, C.; Reche, C.; Massagué, J.; Via, M.; Minguillón, M.C.; Alastuey, A.; Querol, X. Changes in air quality during the lockdown in Barcelona (Spain) one month into the SARS-CoV-2 epidemic. *Sci. Total Environ.*, **2020**, *726*, 138540.
12. Crop Farming FAO. Available online: http://www.fao.org/rural-employment/agricultural-sub-sectors/crop-farming/en/ (Accessed on 28 August 2020).
13. Abdelhedi, I.T.; Zouari, S.Z. Agriculture and Food Security in North Africa: a Theoretical and Empirical Approach. *J. Knowl. Econ.*, **2020** (in press).
14. Kogo, B.K.; Kumar, L.; Koech, R. 2020. Climate changeand variability in Kenya: a review of impacts onagriculture and food security. *Environ dev sustain*, **2020** (in press).
15. Lopez-Ridaura, S.; Barba-Escoto, L.; Reyna, C.; Hellin, J.; Gerard, B.; van Wijk, M. Food security andagriculture in the Western Highlands of Guatemala. *Food Secur.*, **2019**, *11*, 817-833.
16. Food and Agriculture Organization. Available online: http://www.fao.org/2019-ncov/en/ (Accessed on 28 August 2020).
17. Held, D.; McGrew, A.; Goldblatt, D.; Perraton, J. Globalization. *Glob. Gov.*, **1999**, *5*, 483–496.
18. Krishner, J. Globalization, American Power, and International Security. Political Sci. Q., 2008. 123, 363–389.
19. Cecchine, G.; Moore, M. Infectious disease and national security: strategic information needs. Santa Monica, CA: RAND Corporation, USA, 2006; pp. 97-105.
20. Air pollution would decrease resistance to coronavirus and facilitate its spread. Available online: https://translate.google.com/translate?hl=en&sl=fr&u=https://www.actu environnement.com/ae/newsletter/newsletter_quotidienne.php%3Fid%3D2526&prev=search&pto=aue (Accessed on 28 August 2020).
21. Air pollution and Covid 19. Available online: https://translate.google.com/translate?hl=en&sl=it&u=https://www.dors.it/page.php%3Fidarticolo%3D3454&prev=search&pto=aue (Accessed on 28 August 2020).
22. Airborne Nitrogen Dioxide Plummets over China. Available online: https://eijournal.com/slider-images/airborne-nitrogen-dioxide-plummets-over-china?doing_wp_cron=1598378076.4186730384826660156250 (Accessed on 28 August 2020).
23. Air Traffic Statistics and COVID-19 Media Kit. Available online: https://www.iata.org/en/programs/safety/health/diseases/ (Accessed on 28 August 2020).

24. COVID-19 Educational disruption and response. Available online: https://en.unesco.org/themes/education-emergencies/coronavirus-school-closures (Accessed on 28 August 2020).
25. COVID-19: 10 steps for transferring your course online. Available online: https://www.weforum.org/agenda/2020/03/covid-19-10-steps-online-learning/ (Accessed on 28 August 2020).
26. The COVID-19 pandemic has changed education forever. This is how. Available online: https://www.weforum.org/agenda/2020/04/coronavirus-education-global-covid19-online-digital-learning/ (Accessed on 28 August 2020).
27. Rana, H. R.; Lal, M. E-learning: Issues and Challenges. *Int. J. Comput. Appl.*, **2014**, 97, 20-24.
28. Yusuf, B. N. M.; Ahmad, J. Are we prepared enough? A Case Study of Challenges in Online Learning In A Private Higher Learning Institution During The Covid-19 Outbreaks. *Adv. soc. sci.*, **2020,** *7*, 205-212.
29. COVID-19 Pandemic: Impact and strategies for education sector in India. Available online:https://government.economictimes.indiatimes.com/news/education/covid-19-pandemic-impact-and-strategies-for-education-sector-in-india/75173099 (Accessed on 28 August 2020).
30. Dawadi, S.; Giri, R.; Simkhada, P. Impact of COVID-19 on the Education Sector in Nepal - Challenges and Coping Strategies. *Sage*, **2020**, (Preprint).
31. Weeden, K. A.; Cornwell, B. "The Small World Network of College Classes: Implications for Epidemic Spread on a University Campus." *SocArXiv*, **2020**, (Web).
32. Medema, G.; Heijnen, L.; Elsinga, G.; Italiaander, R.; Brouwer, A. Presence of SARS-Coronavirus-2 RNA in Sewage and Correlation with Reported COVID-19 Prevalence in the Early Stage of the Epidemic in The Netherlands. *Environ. Sci. Technol. Lett.* **2020**, *7*, 511–516.
33. Medam, J.; Heijnen, L.; Elsinga, G.; Italiaander, R.; Brouwer, Anke. Presence of SARS-Coronavirus-2 in sewage.*Environ. Sci. Technol. Lett.* **2020** [Just accepted].
34. Milan announces ambitious scheme to reduce car use after lockdown. Available online:

    https://www.theguardian.com/world/2020/apr/21/milan-seeks-to-prevent-post-crisis-return-of-traffic-pollution (Accessed on 28 August 2020).
35. COVID-19 Crisis: Nepal Export Revenues from NTIS Products down by 18%. Available online: https://www.nepalisansar.com/government/covid-19-crisis-export-revenues-from-ntis-products-down-by-18/ (Accessed on 28 August 2020).
36. Air Traffic Statistics and COVID-19 Media Kit. Available online: https://www.iata.org/en/programs/safety/health/diseases/ (Accessed on 28 August 2020).
37. New dynamic" needed to overcome negative impact of COVID-19 worldwide. Available online: https://news.un.org/en/story/2020/07/1067801 (Accessed on 28 August 2020).
38. Edelhauser, E.; Lupu-Dima, L. Is Romania prepared for eLearning during the COVID-19 Pandemic? *Sustainability*, **2020**, *12*, 5438.
39. REPORT: COVID-19 impact on air quality in 10 major cities. Available online:

    https://www.iqair.com/blog/air-quality/report-impact-of-covid-19-on-global-air-quality-earth-day (Accessed on 28 August 2020).
40. Cheval, S; Adamescu CM; Georgiadis, T; Herrnegger, M; Piticar, A; Legates, D.R. Observed and Potential Impacts of the COVID-19 Pandemic on the Environment, *Int. J. Environ. Res. Public Health* ,**2020**, 17, 4140.
41. Quere, C. L.; Jackson, R.B.; Jones M.; Adam, W.; Smith J. P.; Abernethy, A.; Andrew R.M.; Anthony J. De-Gol,.. Peters, G.P. Temporary Reduction in Daily Global CO_2 Emissions during the COVID-19 Forced Confinement. *Nat. Clim. Change*, **2020.**

42. Lokhandwala, S.; Gautam, P. Indirect Impact of COVID-19 on Environment: A Brief Study in Indian Context. *Environ. Res.*, **2020**, *88*, 109807.
43. The Coronavirus Pandemic Has Caused Carbon Emissions To Drop. But That Likely Won't Last. Available online: https://time.com/5864374/coronavirus-carbon-emissions/ (Accessed on 28 August 2020).
44. Barbieri, D.M.; Lou, B.; Passavanti, M.; Hui, C.; Lessa, D.A.; Maharaj, B.; Banerjee, A.; Wang, F.; Chang, K.; Naik, B.; Yu, L.; Liu, Z.; Sikka, G.; Tucker, A.; Foroutan Mirhosseini, A.; Naseri, S.; Qiao, Y.; Gupta, A.; Abbas, M.; Fang, K.; Ghasemi, N.; Peprah, P.; Goswami, S.; Hessami, A.; Agarwal, N.; Lam, L.; Adomako, S. Perceived air pollution in Australia, Brazil, China, Ghana, India, Iran, Italy, Norway, South Africa, USA before and during COVID-19 restrictions, *Data Brief*, **2020**, *32*, 106169.
45. Keeping food and agricultural systems alive: Analyses and solutions in response to COVID-19. Available online: http://www.fao.org/2019-ncov/analysis/en/ (Accessed on 28 August 2020).
46. FAO. Comparing Crises: Great Lockdown versus Great Recession. Available online: http://www.fao.org/3/ca8833en/CA8833EN.pdf (Accessed on 28 August 2020).
47. COVID-19 and Food Safety: Guidance for food businesses: Interim guidance. Available online: https://www.who.int/publications-detail-redirect/covid-19-and-food-safety-guidance-for-food-businesses (Accessed on 28 August 2020).
48. FAO. Available online: http://www.fao.org/rural-employment/agricultural-sub-sectors/livestock/en/ (Accessed on 28 August 2020).
49. COVID-19: Channels of transmission to food and agriculture. Available online: http://www.fao.org/3/ca8430en/CA8430EN.pdf (Accessed on 28 August 2020).
50. WFC, Available online: https://www.worldfishcenter.org/why-fish (Accessed on 28 August 2020).
51. COVID-19 and the Future of Security and Defense. Available online: https://www.europeanleadershipnetwork.org/person/ilana-bet-el/ (Accessed on 28 August 2020).
52. Coronavirus 'could Cost Global Economy $8.8tn' Says ADB. Available online: https://www.bbc.com/news/business-52671992 (Accessed on 28 August 2020).
53. The Global Economic Outlook during the COVID-19 Pandemic: A Changed World. Available online: https://www.worldbank.org/en/news/feature/2020/06/08/the-global-economic-outlook-during-the-covid-19-pandemic-a-changed-world (Accessed on 28 August 2020).