**THE EMERGING ILLNESS, NOVEL CORONAVIRUS DISEASE 2019: IS THE EARTH FIGHTING BACK MAN'S
UNSUSTAINABLE OCCUPATION?**

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ABSTRACT

Introduction: SARS-CoV, MERS-CoV and SARS-CoV-2 are zoonotic spillovers; with viral recombination, epithelial affectation and poor immunological memory hampering antiviral treatment and vaccination. The theoretical poor infectivity except in the 'super-spread', may have reduced global preparedness.

Objectives: This study examined the evidence supporting the role of biodiversity loss on zoonotic emerging illnesses like SARS-CoV-2.

Study design: Narrative literature review.

Methods: A search-engine search done using keywords (zoonosis, biodiversity loss, species dilution, climate change) yielded the studies for the qualitative synthesis.

Results: Mans' activities (non-renewable energy utilization, elaboration of green-house-gases, land-use changes, habitat transformation, species overexploitation) are linked to biodiversity loss. The ecosystems have become modified with loss of 'species-dilution', with increased zoonotic spillovers; thus the emergence of previously animal diseases in man, like the SARS-CoV and SARS-CoV-2 from bat coronaviruses.

Conclusion: The tackling these emerging challenges should include enforcing climate change mitigation and adaptation alongside curbing other causes of biodiversity loss.

KEYWORDS

COVID-19; Coronavirus; Climate Change; Biodiversity loss; Zoonosis; Environmental sustainability

1.0 Introduction

It's common knowledge that the invisible governs the visible. This explains the pandemic of the novel corona virus disease (COVID-19).

The COVID-19 is caused by a family of constantly mutating (recombining), enveloped, non-segmented, positive strand (sense), RNA (ribonucleic acid) viruses, infecting mostly vertebrates [1,2]. This family of coronaviruses (coronaviridae) has upwards of 2500 viral species and the largest viral genome; up to 33.5 kilobase [2,3]. The 'Corona-' prefix comes from their spherical virion with club-like spikes, resembling the solar-corona. The average size is 65-125 nanometers; being slightly larger than the SARS-CoV (of the SARS pandemic) and MERS-CoV (of the Middle East Respiratory Syndrome) [2,3,4]. It has a viral genome, phospholipid membrane and four structural proteins, the S (spike), E (envelope), N (nucleocapsid) and M (membrane) proteins [1,2,3]. It commonly affects the lower respiratory tract, causing acute lung injury and acute respiratory distress syndrome [3].

The phylogenetic origin includes: Realm - Riboviria, Order - Nidovirales, Sub-order - Cornidovirineae (others here are Arterivirineae, Mesonivirineae and Ronivirineae), Family - Coronaviridae (other is Toroviridae). There are two coronaviridae Sub-families, five Genera, twenty seven Sub-genera and thirty nine Species [1,2,3].

The names include, severe acute respiratory syndrome-related coronavirus-2 (SARS-CoV-2), being 79% homologous to the SARS-CoV and upwards of 96% homologous to the bat coronavirus [4]. It's also called Wuhan coronavirus based on initial isolation site. However, the coronaviridae study group (CSG) of the International Committee on Taxonomy of Viruses (ICTV) having reviewed the phylogenetic data, date of onset, location of first isolation and host, have proposed a naming convention for the coronaviruses as follows, virus/host/location/isolate/date, so this novel coronavirus is named thus, SARS-CoV-2/ human/ Wuhan/ X1/ 2019 [1,3].

2.0 The coronavirus human diseases

The SARS-CoV-2 disease 2019 pandemic is the third documented coronavirus zoonotic spillover twenty years, causing epidemics [1].

The SARS-CoV causing Severe Acute Respiratory Syndrome originated in Guangdong, China from November 2002 to July 2003[2,3]. It's linked to Chinese horseshoe bats, palm civets and raccoon dogs [2]. SARS is now endemic, causing about 15 - 30% of respiratory tract infections, with severe disease in the neonates, the elderly and persons with significant comorbidities [2]. When controlled, 8098 cases were confirmed with 779 deaths, mortality rate of 9.6% and estimated economic loss of 40 billion USD [2,3].

The MERS-CoV was the cause of the Middle East Respiratory Syndrome in 2012, in Saudi-Arabia and involving other states [1,3,4]. It initially had a 50% mortality and 40% case fatality rate by August 2014, with 855 confirmed cases and 333 deaths [2]. At full control, there were 2428 confirmed cases and 838 deaths [3]. It's most significant animal hosts are camels, but also bats, rabbits and horses [2].

In December 2019, the World Health Organization was notified of 50 confirmed cases of SARS-CoV-2 infection in Wuhan, China [1,3,4]. The main cluster was around the Hunan seafood market, where it's common practice to sell live animals like bats, frogs, snakes, birds, marmots and rabbits [3]. The disease is yet uncontrolled, with confirmed cases globally at 3,003,392 and deaths 207,096 persons with 882,668 persons having recovered as of April 27th, 2020; of the currently infected 1,886,704 persons, only 3% (57,553 people) are critically ill [5,6]. Its main local features are the flu-like symptoms but with propensity for affecting the lower respiratory tract as well and being sister clade with the prototype SARS-CoV, they also affect newborns, the elderly and persons with comorbidities (like cardiovascular disease, diabetes mellitus, chronic respiratory disease, hypertension, etc) with more propensity [2,4].

2.1 Pathogenesis of the coronavirus human diseases

2.1.1 Transmission: Until the SARS-CoV outbreak, the coronaviruses were addressed as not transmissible to man, their zoonotic spillover comes from rhinolopus bats (amongst others), palm civets, raccoon dogs, etc, by direct contact or by eating them [2,3]. The human-to-human transmission was largely inefficient for the SARS-CoV and MERS-CoV, requiring direct contact after the onset of illness, with super-spreads occurring in people with high viral burden and /or aerosolizing the virus [2].

2.1.2 Target cells: Most commonly infected are the epithelium of the lungs, also infected are macrophages and dendritic cells[2,3].

2.1.3 Entry of virion and multiplication: The processes of entry of the virion into the target cell, viral genome replication, viral protein synthesis and production of more viruses are as follows:

1. ***S-protein interaction with its human receptors:*** On the S-protein are receptor-binding domain (RBD) sites within the S1 region. These sites vary among species, SARS-CoV and SARS-CoV-2 use the angiotensin converting enzyme-2 (ACE2), while the MERS-CoV uses the dipeptidyl-peptidase-4 (DPP4) [2,3].
2. ***Virus entry into cell cytosol:*** They first induce an acid-dependent proteolytic cleavage of Spike protein by a cathepsin, transmembrane protease serine 2 (TMPRSS2) and /or human airway trypsin-like protease (HAT); elaborating penetration changes [2,3]. The viral and cellular membranes fuse, and viral genome is released into the cytosol [2,3].
3. ***Expression of replicase proteins:*** The replicase gene is translated from the viral RNA encoding two large proteins (Rep1a and Rep1b), they have transmembrane domains on which the replication-transcription complex is anchored for the replication to proceed [2].
4. ***Replication and transcription:*** The assembling of the viral replicase complex starts RNA synthesis of genomic and sub-genomic RNAs. At this stage, RNAs are able to recombine using homologous and non-homologous recombination; this plays a prominent role in viral evolution [2,3].

5. ***Viral assembly and release:*** The structural proteins are then translated and placed in the endoplasmic reticulum and then to the endoplasmic reticulum-Golgi body complex. Following assembly of virion, they are transported to the cell surface in vesicles and released via exocytosis [2,3].

2.2 Diagnosis

Diagnosis making follows case definition, contact tracing, and screening with multiplex realtime polymerase chain reaction and serologic assays [3].

2.3 Treatment of the coronavirus human disease

No proven cure exists yet, putative drugs and vaccines are at different stages of drug development.

The mainstay of care is supportive. Respiratory efforts are supplemented or taken-over by mechanical ventilation. Fluids, electrolytes and calories are provided intravenously or enterically. Other systems are monitored and supported as necessary; especially renal functions, monitored with urine output and kidney function tests[3].

The 'flatten-the-curve' concept, promotes transmission rates reduction and preventing overwhelming of health systems. The policies of social distancing, proper and regular hand hygiene and avoiding touching the face, etc, have been beneficial [6].

3.0 Methodology

Study objective: This study presents evidence supporting the impact of biodiversity loss on zoonotic emerging illnesses like SARS-CoV-2.

Study design: The study is a narrative literature review.

Hypothesis: If zoonotic emerging illnesses are caused by ecosystem distortions, then climate change and other drivers of biodiversity loss cause zoonoses.

Review process: A brief review of the SARS-CoV-2 was done using available recent literature.

The review followed premises established by the study hypothesis. A search-engine search was done using a-priori and post-priori keywords. The keywords were: zoonosis, biodiversity loss, climate change, species dilution, mitigation and adaptation.

Recent and representative studies were selected. Data were extracted and analysed to achieve the study objectives.

The data were then used for the narrative synthesis by placing them into sections for the writing of the manuscript.

4.0 Climate change: Man's unsustainable occupation has a key role.

Our climate (rhythmic weather changes over a period of at least 30 years) has evolved to significantly changing weather rhythms and a hotter atmosphere with multiple sequelae. Similar climatic drifts have been implicated in the previous five *mass extinction events*; hence, a sixth is imminent in the absence of mitigation and adaptation [7,8].

Climate change occurs following imbalances in the entry and exit of exogenous radiation into our atmosphere. The earth's ozone layer serves for impeding entry of detrimental cosmic rays. Our atmosphere has a layer of green house gases (GHGs), preventing temperature loss from the earth [7,8].

The Ozone layer is progressively depleted by emissions (like hydrofluorocarbons), with loss of its shielding effects. The levels of GHGs have increased following withdrawal of plants' carbondioxide absorptive role,

natural gas flaring and unregulated fuel combustion. Increased GHGs have caused increased atmospheric temperature and water vapour [7,8].

4.1 Evidence of climate change

Apart from the hotter atmospheric temperatures (with average temperature rises 2.0 - 6.4 °C above previous baseline values), increased flooding and ocean-related disasters (Tsunamis, Cyclones, Tornadoes, etc); objective measures of weather data acquired from Greenland and Antarctica ice-core data have revealed climatic transitions over millennia [7,8,9].

Direct observation evidence include rising sea levels (estimated to reach 8-88 cm above baseline before year 2100), increased shedding of polar and glacial ice, droughts, forest fires and the indirect linkages to population displacement and unrest, as well as decreased food production, malnutrition, and major biodiversity loss as well as emerging illnesses [7,8,9].

4.2 Causes of climate change

Man is a major role player in climate change with a resulting negative tide in man's direction. The factors are presented below [7,8].

Factors increasing GHGs; like Indiscriminate felling of trees, continuous flaring of natural gas and other metabolites of combustion [7,8].

Increased mechanized agriculture; increasing atmospheric nitrous oxide levels [7].

Depletion of the earth's ozone layer, causing the 'Ozone Hole'; necessitating the establishing of the Ozone Secretariat in UNEP, Nairobi, Kenya, after the Vienna Convention and Montreal Protocol of 1987. The major contributors are: **chlorofluorocarbons (Freons)** from aerosols, refrigerants and air conditioning. Freons in the stratosphere, in the presence of UV light dissociate, yielding chlorine which disassembles

ozone in the gaseous phase. **Bromocarbons (Halons)** from extinguishers and agricultural pesticides generate bromine, acting like chlorine above [7,8].

4.3 Effects of climate change

The result of these climate drifts include effects from the rising levels of the GHGs as well as those related to the breach in our ozone layer; these are presented below.

Effects related to increasing GHGS:

- A) Global atmospheric temperature elevations, melting of glacial ice,, Increased flooding and droughts, sea level rise and salinization of soil water, marine instability and disasters like tropical cyclones, tornadoes, tsunamis, etc [7,8].
- B) Ocean acidification from catalytic absorption of carbondioxide by the oceans' waters [7].
- C) Health problems like heat stress and stroke, diabetes, water-related diseases, Infectious (zoonotic mostly) diseases, malnutrition and food poisoning, mental health problems [7].

Effects related to breach in the Ozone layer:

Unimpeded entry of cosmic rays like ultraviolet-B (UVB) light, and other long wave irradiation, increasing incidence of cancers (e.g., basal and squamous cell cancers, mslignant melanoma) and cataracts. Formation of trophospheric ozone, with food insecurity from reduction in economic crops yield and decimation of planktons [7].

5.0 Biodiversity loss

Human-related biodiversity loss causes are largely irreversible; the losses in the past 50 years have been the worst in human history [9].

It's estimated that water reservoir capacity has quadrupled; such that water in large dams is three to six fold the amount of water flowing through rivers at any singular time [9]. In the last two decades, 35% of the mangroves were lost [9], and in the past few centuries, human-related species extinction rates were upwards of 1000 fold previous baseline rates [9].

A single species decline or decimation results in a web of infinite width. Let's create a scenario that may apply adequately to us [9].

Aquatic species loss will be used as a case for review. Of the two major protein sources (animal and plant) for man, animal protein is known to have more protein yield than their plant counterparts. The animal protein sources are wild or domesticated; more so, they are either aquatic or terrestrial. Earth is >70% water and so is the aquatic population significantly more [7].

Over the past 60 years, advancements in fishing techniques (good as it were) has resulted in an 'Overfishing' of our oceans, the Seafood catch had increased from the global annual average in the year 1950 of about 18 million tons to 168 million tons in 2000, with ten fish species accounting for upwards of 30 percent of the fish catch [7,10,11,12,13]. Sequel to this massive overfishing, there became little yield from that protein source as the global fish catch had declined to 79.5 million tons in 2008 [10,11,12]. Man had to shift to the next available source, 'Bushmeat'. It has been explored for some years as well, and has now become accepted that some wild infectious strains (unarguably, the human coronaviruses are zoonotic spillover) have gained access into Humans by our increased consumption of bushmeat (the more available wild animal protein), it is no longer news that HIV 1 was thought to have been acquired from wild chimpanzee consumption [1,2,3 7].

In Madagascar, the incidence of Iron deficiency anemia has significantly increased owing to the unavailability of ready seafood supply as well as a significant decline in wild meat, hence the major iron source for these people is cut short. Now, it is presumed that effects of over fishing in the developed

world has deprived the developing world of fish because they are mostly dependent on seafood for protein, and they lack improved technology to step up fishing prowess required to meet present day fishing requirements [7]. Another lead is that seafood access has shifted to 'Aquaculture'; most of the feed for these fishes is called Fish meal; the contribution of aquaculture to the global fish supply has significantly increased, from the initial 26% in 1994 to 44% in 2014 [13,14,15]. Fishmeal is gotten from the good old 'Fisheries, that were wildly harvested fishes and manufactured into fishmeal, hence the world has re-directed its attention, now rather than only eating oceanic fish, we started using it to feed our little pen-based or land-based aquaculture [13,14]. Even more sadly, it was found out that most of the fishmeal found itself being used for livestock rearing (Pigs, and poultry especially); in the 1960's, fishmeal was almost not used for aquaculture, it was used for pigs and poultry in equal amounts (that is 50% each); the trend was shown to have changed by 2008 when 58% of the fishmeal went to aquaculture, but the rest was largely pooled into swine rearing [7]. There became a global pig boom, in a proportion such that we have a pig for every eight humans. China accounted for >50%% of the global swine production; there was however no significant increase in the swine farms space, thus, they were rather clumped into the previous space most of the times, resulting in overcrowding (Intensification) [7]. This was the perfect medium for microbial sharing, and thus increased use of antibiotics to prevent infections; this was also perfect scenario for brewing of antibiotics resistance and then a transmission of these antibiotic resistant microbes to man, this was thought to be implicated in the development of 'Methicillin Resistant *Staphylococcus aureus*' [7].

5.1 Causes of biodiversity loss

Climate change is incontrovertibly accepted by most experts as the current leading cause of biodiversity loss. The causes can be categorized as direct or indirect. The direct causes include: climate change, land use change, habitat transformation (like modification of rivers or water sequestration in dams),

overexploitation (especially overfishing). Indirect causes include demographic shifts, economic burden, socio-political instability, ethno-religious as well as science and technological advancements [9,10,11,12,16].

It is important to note that most of the causes of biodiversity loss are significantly related to human activity.

5.2 Modification of ecosystems and the concept of loss of 'species-dilution '

Ecosystem modification has been a well reported consequence of biodiversity loss, it has been shown that a reduction in the species diversity in ecosystems has been associated with increased infectious disease causation (especially zoonosis); a phenomenon described as 'the species dilution effect' [16,17,18].

This was originally discovered in the animal-human transmission of tick-borne Lyme disease; caused by the bacterium *Borrelia burgdorferi*, when a blacklegged tick (*Ixodes scapularis*) -its primary vector- successfully feeds from an infected host. The most common competent host species are white-footed mice (*Peromyscus leucopus*), short-tailed shrews (*Blarina brevicauda*), masked shrews (*Sorex cinereus*) and eastern chipmunks (*Tamias striatus*) [18]; but the *Ixodes* tick can feed from many vertebrate species including birds, reptiles and mammals. Many of these hosts however, show low 'realized reservoir competence' and are unable to successfully transmit the bacteria to the vectors, but with widespread ecological modifications (man-made; deforestation and natural/ climate change-related; wildfires especially) resulting in death of the less competent hosts, the white-footed mice and its cohorts were more readily available to be fed on and thus the ability for the adult *Ixodes* ticks to be lyme disease laden [18].

A similar scenario had been reported for other infectious diseases like the West Nile virus, which is transmissible from many bird species, with its most competent hosts in North America being the American Robins, Common Grackles, and Blue Jays [18].

Another example is seen amongst Rodents, with many species that are resilient to anthropogenic environmental events and are efficient hosts for zoonotic pathogens, including those that cause Lyme disease, hantavirus diseases, plague, leishmaniasis, various hemorrhagic fevers (e.g. Lassa fever and Ebola virus disease), and babesiosis [18].

6.0 Conclusion and Solutions to climate change

6.1 Conclusions

The SARS-CoV-2 being sister clade with the zoonotic spillover related SARS-CoV and not unlike the MERS-CoV are the most significant coronaviruses of implications to man lately. Whilst being theoretically lowly infectious, the strength of their viral genome recombination is potentially infinite and may be implicated in the not-so-clear modes of spread (enabling its pandemic scale) of the SARS-CoV-2 as well as the difficulties in developing satisfactory immune response and memory, vaccine development and specific antiviral agents. The homology of these viruses with those infecting bats, palm civets, raccoon dogs amongst others as well as the origins of these diseases in places with notoriety for handling and consumption of these animals, has elaborated the zoonotic mode of entry from animal to man. The theories of loss of 'species dilution', related to man's activities culminating in biodiversity loss (from climate change effects and overexploitation of species, habitat modifications, etc) have been described in many zoonoses and must be very more closely explored to prevent future emerging infectious diseases.

6.2 Solutions to climate change

The solutions to climate change would putatively reverse some of its sequelae like biodiversity loss and thus help to rescind capacity for zoonotic spillover. A reduction in these will no doubt provide a decline in the emergence of emerging infections, especially those of a pandemic scale.

The globally accepted solutions are generally grouped as either mitigations or adaptations.

Mitigation basically refers to preventive strategies set in place to curb the ongoing climate change scourge. Some major principles according to the 'Stabilization Wedges theory in place include [19,20,21,22]:

Category I: Energy efficiency and conservation; efforts here are centered on the high energy requiring areas of Electricity, Transportation and Heating. Here we aim to double the fuel economy of auto-vehicles, a complete phasing out of high energy utilizing appliances for their contemporaries (eg Substitution of Incandescent bulbs for fluorescent bulbs etc)

Category II: Fuel switching (Replace coal-fired Electric plants with Natural Gas power plants), Carbon capture and storage

Category III: Renewable fuels and Electricity (Use Wind driven electric plants to replace coal-fired ones, improve the capacity of Solar electricity generation and encourage production and use of biofuels by scaling up ethanol production and the planting of biofuel crops), Forests and soil storage(Halt tropical deforestation and afforestation, as well as ensure conservation tillage on cropland).

Category IV: Nuclear fission (Globally increase nuclear electricity generation)

Adaptation basically describes the salvage actions set in place to deal with the already evident and developing sequelae of climate change. Common examples include [20,22]:

Emergency response teams enshrined with responsibilities ranging from identification of through to combating natural disasters.

Mass sensitization on Global Climate change

Evacuation of Disaster prone terrains

Contributions of the global community under the auspices of the UN at the Vienna Convention' of 1987 resulting in the development and supervised execution of the "Montreal Protocol has been shown to significantly reduce the generation of Freons and Halons (that are significantly implicated in the destruction of our Stratospheric Ozone layer shield), hence a decline and apparent halting of the previously exponential rate of destruction of our Ozone layer.

7.0 Ethical Approval statement and declaration of conflict of interests

Ethical approval was not sought for this study. The study was a secondary data analysis, not conducting any experiments on neither humans nor animals and thus having minimal likelihood of need for ethical considerations.

The author has no conflicts to declare and no funding was received for this study.

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