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Invited Contribution

COVID-19: Neo-Malthusianism, Ecological Links, and Challenges for Humanity

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ABSTRACT

The fact of human appropriation of resources of biosphere exceeding the regenerative capacity of the latter is at the root of the erosion of biospheric resources. Such erosion of biosphere is unfolded in the forms of deforestation, habitat loss of wild species and biodiversity loss. The origin of the current COVID-19 pandemic is traceable to transmission of the concerned virus from zoonotic sources to humans due to closer contacts of wild life to humans caused by the biodiversity loss. The pandemic has an obvious Neo-Malthusian message giving us the warning of the dangerous consequences of persistence of such biodiversity loss and points to the necessity of reversal of this trend and the resulting impact inequality for restoring the condition of sustainability. The paper highlights these issues and also the adverse economic impact of the pandemic particularly on economic growth and social well-being as experienced in India.

Kew Words: Pandemics; Deforestation; Biodiversity; Globalization; Ecosystem Functioning

CORONAVIRUS-19 (COVID-19) AS AN EXTREME EVENT DUE TO DESTRUCTION OF THE NATURAL WORLD

This paper focuses on the origin of the huge existential crisis currently faced by the humanity due to the highly infectious Coronavirus disease pandemic. Although the world is still in the midst of the pandemic, so that we cannot as yet make a total assessment of its impact and sustainability policy implications, all the countries of the world are already affected by this pandemic in a manner that their socio-economic life has been derailed from its normal course of movement. The total number of cases of infection worldwide due to this COVID-19 reached 13,487,894 as on 15th July 2020, out of which 7,878, 258 people recovered and patients died in 581,981 cases. There have been worldwide 50,27,655 active cases as on 15th July, 2020. Figure 1 shows the rapid increase in the total number of cases worldwide (includes deaths and recovered or discharged patients). Table 1 shows

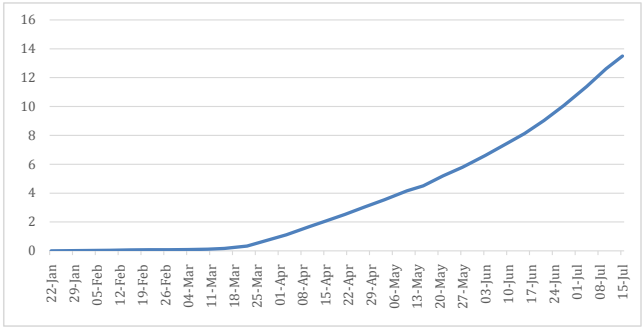

Figure 1. Total number (millions) of cases worldwide
(*Source: https://www.worldometers.info)*

total number of cases, total deaths, total recovered, total active cases as well as total cases per million population and deaths per million population across countries as on 15th July, 2020.

India is in 3rd position among the countries in the World in terms of total number of cases as on 15th July, 2020. Table 2 presents state-wise number of active cases, cured/discharged/migrated cases, deaths and total confirmed cases of COVID-19 for India as on 15th July, 2020. At the start of lockdown, i.e. on 25th March, 2020, total number of confirmed cases in India stood at 563 which spiked to 936,181 by 15th July, 2020. As of 15th July, 2020, there was 24,309 deaths in India due to COVID-19, among which 44% of deaths occurred in Maharashtra (10695 deaths), followed by Delhi (14%), Tamil Nadu (9%) and Gujarat (9%). These reveal seriousness of the prevalence and regional concentration of risk of life involved in the disease.

Table 1. Total number of cases, total deaths, total recovered, active cases, total cases per million population and deaths per million population across countries as on 15th July, 2020 (Source: https://www.worldometers.info)

S. N.	Country	Total Cases nos.	Total Deaths nos.	Total Recovered nos.	Active Cases nos.	Total Cases per million population	Deaths per million population
1	USA	3,546,278	139,162	1,600,910	1,806,206	10,711	420
2	Brazil	1,931,204	74,262	1,213,512	643,430	9,083	349
3	India	939,192	24,327	593,198	321,667	680	18
4	Russia	746,369	11,770	523,249	211,350	5,114	81
5	Peru	333,867	12,229	223,261	98,377	10,121	371
6	Chile	319,493	7,069	289,220	23,204	16,708	370
7	Mexico	311,486	36,327	193,976	81,183	2,415	282
8	Spain	303,699	28,409	NA	NA	6,495	608
9	South Africa	298,292	4,346	146,279	147,667	5,027	73
10	UK	291,373	44,968	NA	NA	4,291	662
11	Iran	264,561	13,410	227,561	23,590	3,148	160
12	Pakistan	255,769	5,386	172,810	77,573	1,157	24
13	Italy	243,344	34,984	195,441	12,919	4,025	579
14	Saudi Arabia	237,803	2,283	177,560	57,960	6,827	66
15	Turkey	214,993	5,402	196,720	12,871	2,548	64
16	Germany	200,766	9,144	185,500	6,122	2,396	109
17	Bangladesh	193,590	2,457	105,523	85,610	1,175	15
18	France	172,377	30,029	78,597	63,751	2,641	460
19	Colombia	159,898	5,625	68,806	85,467	3,141	111
20	Canada	108,486	8,798	72,170	27,518	2,873	233
21	Argentina	106,910	1,968	45,467	59,475	2,365	44
22	Qatar	104,533	150	101,160	3,223	37,229	53
23	Egypt	83,930	4,008	25,544	54,378	820	39
24	China	83,611	4,634	78,693	284	58	3
25	Iraq	81,757	3,345	50,782	27,630	2,031	83
26	Indonesia	80,094	3,797	39,050	37,247	293	14
27	Sweden	76,001	5,545,	NA	NA	7,524	549
28	Ecuador	69,570	5,130,	30,484	33,956	3,941	291
29	Belarus	65,443	480	56,379	8,584	6,926	51
30	Kazakhstan	63,514	375	38,008	25,131	3,381	20
31	Belgium	62,872	9,788	17,242	35,842	5,424	844
32	Oman	61,247	281	39,038	21,928	11,985	55
33	Philippines	58,850	1,614	20,976	36,260	537	15
34	Kuwait	56,174	396	46,161	9,617	13,147	93
35	Ukraine	55,607	1,427	28,131	26,049	1,272	33
36	UAE	55,573	335	46,025	9,213	5,617	34
37	Netherlands	51,146	6,135	NA	NA	2,985	358
38	Bolivia	50,867	1,898	15,819	33,150	4,356	163
	Other countries	1,147,355	30,288	935,006	819,223	-	-
	World	13,487,894	581,981	7,878,258	5,027,655	1,730	74.7

Note: NA represents not available. Data is accessed on 15th July, 2020

Table 2: COVID-19 statistics across states in India

S. N.	Name of State / UT	Active Cases	Cured/Discharged/Migrated	Deaths	Total Confirmed cases
1	Andaman and Nicobar Islands	57	109	0	166
2	Andhra Pradesh	15,144	17,467	408	33,019
3	Arunachal Pradesh	306	153	3	462
4	Assam	6,351	11,416	40	17,807
5	Bihar	6,261	12,849	174	19,284
6	Chandigarh	144	446	10	600
7	Chhattisgarh	1,084	3275	20	4,379
8	Dadra and Nagar Haveli and Daman and Diu	209	310	1	520
9	Delhi	18,664	93,236	3,446	115,346
10	Goa	1,128	1,607	18	2,753
11	Gujarat	11,065	30,503	2,069	43,637
12	Haryana	5,226	17,090	312	22,628
13	Himachal Pradesh	347	951	11	1,309
14	Jammu and Kashmir	4,755	6,223	195	11,173
15	Jharkhand	1,628	2,427	36	4,091
16	Karnataka	,	17,390	842	44,077
17	Kerala	4,458	4,438	34	8,930
18	Ladakh	146	946	1	1,093
19	Madhya Pradesh	4,757	13,575	673	19,005
20	Maharashtra	107,963	149,007	10,695	267,665
21	Manipur	702	970	0	1,672
22	Meghalaya	250	66	2	318
23	Mizoram	79	159	0	238
24	Nagaland	550	346	0	896
25	Odisha	4,342	9,864	74	14,280
26	Puducherry	684	829	18	1,531
27	Punjab	2,635	5663	213	8,511
28	Rajasthan	5,885	19,161	525	25,571
29	Sikkim	122	87	0	209
30	Tamil Nadu	47,915	97,310	2,099	147,324
31	Tripura	630	1538	2	2,170
32	Uttar Pradesh	13,758	24,983	983	39,724
33	Uttarakhand	769	2867	50	3,686
34	West Bengal	11,927	19,931	980	32,838
35	Telangana	12,530	24,840	375	37,745
	Cases being reassigned to states	1,524			1,524
	Total	319,840	592,032	24,309	936,181

Source: Ministry of Health and Family Welfare accessed on 15th July, 2020

Note: Active Cases, Cured/Discharged/Migrated and Total Confirmed cases include foreign Nationals.

As we shall see in our more detailed description and analysis of impact of this pandemic across the world from India to United States, it is the poor and economically marginalized section of population, irrespective of if they are black or brown, have been disproportionately hit by the pandemic caused by the virus by losing both life and livelihood, i.e., job and income.

It is also noticeable that India has faced several cyclonic storm with catastrophic impact in recent past. India, in fact, experienced one super cyclone hitting eastern coasts of West Bengal and Orissa on May 2020 which has been unprecedented in terms of wind speed and devastation in the years since 1737 for the region. Another such cyclone hit the western coast near Mumbai on 2nd June 2020. The cyclones with extreme characterization, and their rising frequency arise mainly because of changes in temperature on land and sea. Such extreme events render millions of people homeless, destroy standing crops and valuable plants, and wipe away the dividend of development of infrastructure of the past many years for improving lives of the people, ending up with a huge destruction or wasting of our environmental and manmade capital.

India is also now witnessing forest fires in the Himalayan state of Uttarakhand. Thousands of people are battling the fire which have already burnt about 1900

hectares in that state where there are now 400 burning sites. Such event is also attributable to the exceptionally dry nature of the region caused by the low rainfall in the region.

The combined impact of all these extreme events is likely to be huge, if not disastrous or devastating in terms of loss of life, asset and livelihood. Is such coincidence of pandemic virus borne disease, forest fire, and cyclones as experienced in India accidental or otherwise connected by an underlying common causality or driving factor? Even if these events are coincidental by accident, the coincidence itself constitutes a message sent by nature warning about the deep malady with potent dangerous and devastating impact in the contingent event of such coincidence. However, the commonality among the driving factors of all these events that can be traced is that they are all caused by the human interventions in the form of overuse of resources or bio-capacity of the local and global ecosystems. The Guardian, London of 25 March 2020 issue reported the observation of the UN Environment Chief Inger Anderson as "humanity was placing too many pressures on the natural world with damaging consequences, and warned that failing to take care of the planet meant not taking care of ourselves."

Both the global heating and the destruction of the natural world for farming, mining, infrastructure construction and housing have in fact driven wild life into contact with the humans. The destruction of habitat of wild life and the ongoing climate change are both hurting humanity, COVID-19 being a "clear warning shot". It is, in fact, the concern of the zoologists and medical scientists that far more deadly diseases than COVID-19 exist in wild life (Settele et al. 2020, Johnson et al. 2020) and that today's civilization was "playing with fire". They think that it was always the human behavior that has been responsible for diseases to spill over to humans from zoonotic sources (The Guardian, March 25, 2020).

DEFORESTATION, BIODIVERSITY LOSS, GLOBALIZATION AND COVID-19

According to the United Nations, a huge total natural forest area of 290 million hectares was lost between 1990 and 2015. This deprived billions of large or small animals, birds, insects and other micro-organism who lost their habitats. This deforested area compares in land size almost with that of India (328 million hectares). The consequent current rate of loss of biodiversity on land in this age of *Anthropocene* is now estimated to be 100 to 1000 times faster than during any preceding *geological* age before the arrival of the Homo Sapiens (Dogra, 2020). However, it should also be noted that apart from deforestation, climate change has also forced animals to come close to humans which created opportunities for pathogens in animal bodies to get new hosts in human body. (Bernstein of Harvard School of Public Health as quoted in the Guardian, 25 March, 2020).

It may be noted that since the turn of the century, many new diseases have been linked to the transmission of microbes from animals, birds and other life forms to human being. A Middle Eastern Respiratory Syndrome (MERS), Severe Acute Respiratory Syndrome (SARS), COVID-19, the Avian flu, Swine flu, Zika virus, West Nile virus, etc. are all examples of such zoonotic diseases caused by the pathogens of various kinds jumping from animals to humans. These viruses often emerge in one country and place and then mutate and gets transmitted and established in other regions and continents. Increased interactions between human population and these pathogens (containing these viruses) from zoonotic sources due to deforestation, economic growth, and climate and socio-cultural changes have increased the possibility of the outbreak of the virus related diseases among human population (Wong et al. 2020, Ye et al. 2020, Everard et al. 2020). Experts like Anderson of UN Environment Programme opined that 75% of all emerging infectious diseases come from wild life. The fatality rates of such diseases are often very high (much higher than the coronavirus – 19), like 50% for Ebola, 60–70% for Nipah virus, transmitted from bats in South Asia. But the deep problem is that we do not have adequate understanding as yet about the source or origin of these viruses or the nature of their mutation and their fatality implications for the humans. It is like the throw of a dice to get the answer to any question as the phenomenon is not only random in nature, but possibly so uncertain that the latter cannot be modeled using calculus of probability (Andrew Cunninghum of the Zoological Society of London).

It is to be noted further that destruction of habitat is not the only reason of biodiversity loss and transmission of pathogens from animals to humans. Shift of human preferences in some countries and culture in favor of consuming meat of exotic wild animals resulted in the emergence of wet market of butchering, transporting and selling live wild animals. Globalization has further promoted the transportation of such animals to far and wide places across countries in crammed and unhygienic condition. Such animals are often transported in stressed and immune suppressed condition causing excretion of pathogens from their body. When people are visiting and working in such markets and coming in the intimate

contact of the body fluids of animals, it leads to an ideal situation for the emergence of a mixing bowl for the origin of diseases. (Andrew Cunningham as quoted in the Guardian 25 March, 2020). The ease of fast travel make the spread of such diseases which are mostly highly infectious from human to human and poses the threat of emergence of pandemic. It is in fact Sub-Saharan Africa and several Asian countries where wet markets have developed and led to the fast spread of such virus related diseases. A wet market China's Wuhun province is in fact suspected to be the source of COVID-19.

HUMAN INTERVENTION, NONLINEARITY OF ECOSYSTEM'S FUNCTIONING AND ECOLOGICAL LINK OF CURRENT PANDEMIC

The destruction of forest, fast loss of species – both plants and animals and the market driven trade of biotic species and their artificial cultivation as outlined above led to erosion of biosphere, and emergence and spread of various diseases in this era as outlined above. However, humans are in any case embedded in biosphere as an integral part of it. One may ask: how is it then human behavior can so evolve that it may be held responsible for the loss and exacerbation of the process of biodiversity loss. This can however happen because of two reasons: (a) human intervention to change the land use pattern of the ecosystem for economic development, and (b) nonlinearity of ecosystem's functioning (Dasgupta 2020, Interim Report on the Economics of Biodiversity).

Most of the human activities of appropriation of resources and particularly those involving land use changes cause fragmentation of ecosystems. The sum of productivities of such fragmented ecosystems would in fact be less than that of the integrated undivided one. Most of the deforestation by way of clearing of strips of forest land for agriculture and human settlements, setting up of fences fragmenting grass land preventing migration of animals, developments of mines, township or building up of linear infrastructures like railways and road systems etc. cause fragmentation of forest ecosystem.

In the water areas too freshwater habitats of vertebrates including fishes are also adversely affected in their reproduction and growth by the construction of dams for irrigation and electricity which disturbs and fragments water flows adversely affecting hydrological cycles. The living planet index shows that dams have altered 50% of existing water flows worldwide. This share will go up to 90% if the future dam projects are all implemented fragmenting freshwater hydrology further. Fragmentation obstructs fish migration routes which are critical for spawning and feeding and their dispersal, leading again to biodiversity loss.

The impact of all such fragmentations falls heavily on the habitats of variety of animal species including birds, insects, tree dwelling and other bigger animals - all of which play a crucial role through their interdependences in the integrity and functioning of the ecosystem. Paleobiologists warn us about the implications of such habitat loss as early signals of biodiversity loss.

The nonlinearity of ecosystem's functioning makes, on the other hand, its processes quite complex leading to the emergence of several niches of locally stable eco-regimes along its dynamic path. The ecosystem once caught in one of these locally stable regime would remain there until a big shock comes to displace it depending on its resilience. The nonlinearity also causes segmentation of population of species across eco-regimes as might have unfolded over time and spatially separated places which results in extinction of the species. The accumulation of erosion of bio-capacity of an ecosystem through fragmentation of ecosystems, habitat loss and extinction of species because of human interventions push the ecosystem to a tipping point beyond which it would flip on to a new eco-regime (moving from one niche to another of locally stable eco-regime with erosion of the biotic resource stock and its primary productivity) representing irreversible changes of its characteristics and processes (Dasgupta 2020, Interim Report on the Economics of Biodiversity.)

However, the erosion of biosphere in terms of its biodiversity, reduces fundamentally the resilience of its ecosystems and makes them vulnerable, when exposed to any exogenous shocks through human interventions as referred to above. There may in fact be a shift of regime of the ecosystem which may be catastrophic in nature and lead to disruption of supplies of our food, water and also climate raising serious concern for the sustainability of our health and life support. The coronavirus pandemic is an illustrative case of fall out of such shift of eco-regime as fundamentally driven by the fast loss of biodiversity and erosion of bio-capacity.

Moreover, the process driving the spread of infectious disease like COVID-19 are also nonlinear. With globalization human's ability to intrude into any ecological niche occupied by various organisms with which we have not evolved, have exposed us to new unfamiliar pathogens. The biodiversity loss creates niches for pathogens that are waiting on the side wings in small numbers to explode into large population and creating condition for new pathogens to evolve through

mutations as part of nonlinear process. The continuous or too frequent mutations of the strains of the viruses like COVID– 19 is making the situation highly challenging for the virologists and epidemiologists to precisely pinpoint the nature of origin or cause of the disease and process of its spread. The nonlinearity of behavior of COVID- 19 is such that it is becoming extremely challenging to remove uncertainty regarding the future evolution of the spread, the invention of vaccine and its control and treatment explaining the currently unacceptable fatality rate of the disease. Besides, the quantitative studies regarding the transmission of the infectious disease point to the fact that wide scale movement of people and goods have made the socio-ecological system quite fragile. The human economies in this era of global integration through the mobility of goods and people has eroded the modularity of our socio-economic system and facilitated the emergence of the current pandemic from the invasion of coronavirus from zoonotic sources on cells of human body in one part of the world, the disturbance soon reverberating across the world. In view of all these originating from human pressure and nonlinearity of behavior of ecosystem, one may wonder: can this current pandemic COVID-19 be described as a Malthusian event?

MALTHUSIANISM AND COVID–19

Human society is embedded in biosphere is a part of the totality of ecosystem of the planet. The Coronavirus pandemic as a fall out of loss of biodiversity is causing such fast spread of the disease and such high rate of fatality (ratio of deaths to cases of virus infection) that it shows the fragility of our ecosystem and signs of erosion of its resilience with reference to protection of human health. The famous book authored by Malthus, 'An Essay on the Principle of Population' (1798) had great influence on the development of the classical political economy and even on Darwin's theory of evolution. The essential idea of the Essay was that growth of population in an economy would be limited by the carrying capacity of the nature in terms of bounds on food supply. According to Malthus, the natural fertility of women under the condition of long run equilibrium subsistence wage rate and the environmental socio cultural condition of that time put up such resistance as would contribute towards the realization of some underlying exogenous base rate of growth of population in geometric progression. On the other hand he considered the growth of food production and supply would be in arithmetic progression due to the fixity and scarcity of land of good quality which is responsible for the diminishing returns to land.

As the growth of population is to outpace that of food supply, the environmental resistance factors would result in acute scarcity of food, soaring food prices, rise in poverty, famine, war, diseases and pestilence. These would exercise positive checks on Malthusian population growth in the form of its crash. The most cited examples of Malthusian checks has been the black deaths brought about by bubonic and pneumonic plague that ravaged the late medieval Europe from 14th century for about 150 years. The positive checks of Malthusianism created conditions of under-population, greater productivity growth and lower economic inequality in society creating conditions for the emergence of early capitalism in the 15th century Europe.

However, Malthus's principle was good analytics, but bad futurology. Malthus's prediction did not become true because of migrations from Europe to North and Latin America, New Zealand, and Australia, on the one hand and advancement of science and technology leading to both agricultural and industrial revolution from 17th / 18th century onwards on the other. The latter gave fossil fuels, electricity, rail and road transport along with new agricultural technology. All these raised land and labor productivity, and efficiency of energy use dramatically, and led to revolutionary changes in the facility of transport and communication, facilitating food security through higher food supply. As a fall out of all these humankind developed preventive checks on population growth which became more important and led to the development of a new culture according to which normative living standard for the masses became substantively higher than the Malthusian subsistence minimum implying higher survival rate of the humans in the event of any disease due to hunger and food shortage.

There was however return of ideas of Malthusianism in late nineteen sixties and early seventies with the publications of the neo-Malthusian writings like Tragedy of Commons (Hardin 1968), Population Bomb (Ehlrich 1968), and the Club of Rome Report: Limits to Growth (Medows and Medows 1972). All these writings focused on how the interrelated issues of human numbers, overuse of natural resources and use of the commons of a society play role in determining sustainability of life support and, livelihood and economic well-being of people of an economy. They point out that it is not merely the relation between population size and food supply, but the relationship among population, resource use, pollution and the state of environmental capital stock which would be critical for the vulnerability of common mass. This induced the scientists to take initiatives of development of measures of environmental stress (ecological footprint or carbon footprint) and

its relationship with both human number and human activities and particularly the consumption pattern.

How would we situate the COVID-19 pandemic in the wider context of sustainability and development? We made some empirical investigation to find out if the total number of cases of infection and its fatality per million population have any relationship with some variables (on a priori ground) like density of population, share of urban population, tests per million population, status of human development with inequality adjustment, health infrastructure and services as indicated by the share of health expenditure in GDP, and finally the share of forest cover in the total land area. The results of pairwise correlations using global cross country data of 214 number countries for 2020[1] between the rate of prevalence and that of fatality of the disease with each of these causal variables showed that there exist no significant statistical correlation between the number of cases of infection or that of fatality and population density. However, it is found that both the number of cases and the number of deaths per million population are significantly positively correlated with the share of urban population in total population of a country.

However, it is also important to notice that the inequality adjusted human development indicator, share of health expenditure in GDP and number of tests per million population have all significant positive correlation with both the total number of cases and the number of deaths per million population. Such positive correlation as obtained at cross country level is not surprising since the coverage of data of the present pandemic shows that the highly advanced high income countries with high human development and better health infrastructure were earlier adversely affected and suffered physically more given the history of travel or spread of the virus borne disease across countries. These correlations cannot explain the cause or origin of the outbreak of the disease, but only reflect the degree of cross section association among the concerned variables as revealed by the data on the state of spread and fatality in the period and countries covered.

Since multiple factors might have influenced the infection rate and fatality rate multiple regression models were also estimated based on the same cross section data whose coverage included also some more possible determining variables like GDP per capita, share of urban population, share of trade in GDP, share of elderly and young population, life expectancy at birth, health expenditure per capita, international tourism, hospital beds per thousand people etc. These show that the total number of cases of infection per million of population can be explained using cross country data in terms of GDP per capita in PPP dollar, and share of urban population which are having positive significant partial regression coefficients, and the share of trade in GDP, the share of elderly population and share of young population, all three of which having negative partial regression coefficients. The results for the share of trade in GDP, the share of elderly population are however, opposite of the expected sign.

For the model that was estimated to explain total deaths per million population, it is the number of hospital beds per thousand population, and the life expectancy at birth which are found to have negative partial regression coefficient, while the current health expenditure per capita and international tourist arrival and regional dummy of Europe and central Asia and Latin America and Caribbean have positive significant partial regression coefficient (Sub-Saharan Africa being the omitted regional dummy variable and base of comparison.). The positive partial regression coefficient of GDP- per capita in the case of total cases and current per capita health expenditure in the cases of number deaths can be explained by the spread of the disease and its regional distribution as captured in the coverage of the data.

We also made empirical investigation to explore the determining factors of the prevalence and fatality for the disease in India. We, however, could only get some results on simple correlations between prevalence rate of the disease and the fatality per thousand population with factors like population density and share of urbanization in total population which were both found to be positive and significant independently.

COVID-19 – NEO MALTHUSIAN MESSAGE

Our empirical limited study clearly points that the current pandemic of COVID-19 is not a Malthusian event. Although the pressure of population is not significant explanatory factor for the occurrence of COVID-19 or its scale, the event still has a Neo- Malthusian message. Malthus's major concern had been that the population size would be exceeding the carrying capacity of the ecosystem where the latter is defined in terms of capacity of land to produce food, i.e., the maximum size of population that can be fed with subsistence food basket. The fixity of land and Ricardian law of diminishing returns can explain the population size, without

[1]Country-level data for different socio-economic and demographic indicators depends on availability of data. Data is collected for latest year available. Data related to COVID-19 is for 15th July, 2020.

Table 3: Estimated coefficients from the multiple regression models

	Coefficient	P>|t|
Equation 1: Total cases per million population		
GDP per capita, PPP (constant 2017 international $) 2018	0.069***	0.000
Urban population (% of total population)	31.686*	0.099
Trade (% of GDP) 2017	-10.318**	0.043
Share of elderly population (%) (age 65 and above)	-506.746***	0.000
Share of younger population (%) (age 14 or less)	-270.367***	0.000
Dummy variable for region (Omitted: Sub-Saharan Africa)		
East Asia and Pacific	-3968.652***	0.002
Europe and Central Asia	231.410	0.853
Latin America and Caribbean	-262.336	0.811
Middle East and North Africa	457.956	0.716
North America	1653.761	0.527
South Asia	-1244.694	0.390
Constant	12246.430***	0.000
Number of observations	160	
Adjusted R-squared	0.4364	
Equation 2: Deaths per million population		
Hospital beds (per 1,000 people) 2013	-21.531***	0.003
Life expectancy at birth, total (years) 2018	-2.615***	0.003
Current health expenditure per capita, PPP (current international $) 2017	0.039***	0.000
International tourist arrival (in thousands) 2018	0.003***	0.001
Dummy variable for region (Omitted: Sub-Saharan Africa)		
East Asia and Pacific	-51.412	0.252
Europe and Central Asia	157.474***	0.003
Latin America and Caribbean	98.119**	0.017
Middle East and North Africa	28.262	0.568
North America	-33.345	0.783
South Asia	7.066	0.918
Constant	159.660**	0.011
Number of observations	143	
Adjusted R-squared	0.4199	

Source: Author's estimation based on data collected from https://www.worldometers.info/coronavirus/ and World Development Indicators (accessed on 15th July, 2020)

*Note: ***represents level of significance at 1%, **represents level of significance at 5% and *represents level of significance at 10% level.*

preventive checks to overshoot the carrying capacity. Neo Malthusians do not define the carrying capacity of the ecosystem in terms of capacity of food production, but in terms ecosystem's potential capacity of resource supply to support human consumption of various kinds of goods and services and waste absorption including change of land use for building up fixed infrastructure or changing product mix of the economy as per the changing preference structure of the people with growth of income and change in technology. This should also include the requirement of land use change for carbon sequestration of the carbon – dioxide unabsorbed by ocean or existing photo synthetic green cover. The concept of ecological footprint as defined and estimated globally and country-wise by the Global footprint Network captures this appropriation of all such demand for resources and eco-services of expressed in units of land use of various types as normalized aggregate in terms of per capita cropland of average photosynthetic productivity. Given the availability of land for various types of uses, the regenerative capacity or bio capacity of a country or the earth can be taken to be the aggregate of availabilities of crop land, pasture, forest, water area (both inland and coastal) of fisheries, etc. in similar normalized unit for meeting the need of resource supply for the humans. In case the ecological footprint exceeds

bio-capacity, the measure of excess can be called bio-deficit of our ecosystem. Emergence and growth of bio-deficit would lead to the erosion of our biosphere with the possible following consequences.

(a) Overharvesting of resources of biosphere leading to depletion biotic stock of plants and animals in the areas of land and water area and loss of biodiversity.
(b) Enlargement of carbon footprint due to rise in the concentration of unabsorbed Carbon- dioxide in the atmosphere causing global warming and climate change.
(c) Deprivation of livelihood and basic needs for the poor and marginalized section of population who do not have the property right over land and other natural resources and therefore can share only disproportionately very small share of benefit of bio-capacity of the ecosystem thus limiting of their share of total ecological footprint. Such people will suffer from poverty, hunger, malnutrition and disease and premature death as it is experienced in many poor developing countries of Afro-Asia. The market driven neoliberal regime in these countries ensures the struggle for ultimately limited finite natural resources of this planet ending up with the Darwinian survival of the fittest.

It is to be noted here that these consequences are interactive with each other. For example climate change resulting in extreme events of cyclones, floods and sea level rise and submergence coastal areas would lead to destruction of habitats of wildlife, plants and animal species and their eventual extinction. Sustainable development would thus require the human system to operate within the operational limit of capacity of the biosphere. As the world population exceeded 6 billion mark around 2000 AD, and the ecological footprint as per the global footprint network's demonstration overshoot the bio-capacity of the earth in late 1960's itself, the ecological footprint of the humanity reached a value of 1.7 of our planet in 2016. We have been therefore heavily drawing down the stock of our biospheric resources since the date of overshoot in the sixties. The COVID-19 as we have seen in the earlier sections is a fall out of such heavy loss of such biotic resource stock.

As sustainable development would require social intervention to reverse the trend, it has been important to examine the economics of linkage of ecological footprint and bio-capacity gap with major developmental variables of an economy. As biodiversity loss is at the core of the current problem of unsustainability of our development process, Dasgupta (2020) has addressed this important issue in his interim report on the Economics of biodiversity for the Government of UK.

Dasgupta (2020) takes in fact the measure of ecological footprint to represent the impact of humanity on the biosphere per unit of time. He represents essentially the same measure as defined by global ecological footprint network alternatively as ratio of GDP or Y to the rate of conversion of resources of biosphere for supplying inputs to production and absorbing wastes, into GDP denoted by say, α. However, GDP underestimates the value of contribution of resources of biosphere as there are nonmarket resources and eco-services which provide human life support and support to economic activities. In any case we can take ecological footprint to be $Y/\alpha = y.N/\alpha$ where N is size of population of the economy and y per capita GDP or income per unit of time, following Dasgupta (2020)

On the supply side, eco-services is determined by the stock of ecological resources of the biosphere which grows over time as these resources are regenerative, the size of growth per unit of time depending on the size of the stock S and can be represented by G(S), G being the rate of regeneration. The excess of ecological footprint over G(S) is the bio deficit yielded by the impact inequality $N.y/\alpha > G(S)$ (as Dasgupta 2020 called it). The measure of gap causes depletion of the biotic resource stock S which would lower the value of G(S) contributing to the further rise of the bio-deficit if the size of the footprint remains the same. Since S and G(S) are bounded from above as earth is a finite place and entropy law governs the ecological system, erosion of S is unfolded in the forms of deforestation, destruction of habitats of other species and biodiversity loss. These drive fundamentally the degradation of both human health and the health (regenerative ability) of the ecosystem. The emergence and alarming rate of spread of the infectious disease COVID – 19 is thus giving a warning signal of humanity's crossing the safe operational limits of functioning of the biosphere.

For the long term durable solution of preventing such pandemic disease like COVID-19, it is important that we attain the condition of sustainable development. This implies the requirement that the impact inequality ($Ny/\alpha = 1.7\ G(S)$) as existing in 2019 be converted into impact equality ($Ny/\alpha = G(S)$) over a chosen time horizon. If we assume that the UN Sustainable Development Goal is to be attained by 2030, Dasgupta's interim report points out that given the growth rate of global GDP per capita at the rate of 3.4% and the rate of decline of global natural capital stock at the rate 0.3% per annum as experienced over past the period 1992 to 2014, such conversion of impact inequality into equality would require α to grow at the rate of 9.1% per annum. This is going to be a tall order given the fact that the historic rate of growth of such economic productivity

of bio-resources has been 2.5% per annum. Dasgupta's interim report also points out that even in a situation of zero growth of global GDP and no decline of natural capital stock from now onwards the requirement of growth of the productivity parameter would be 5.4% per annum. One can generate alternative scenarios of dynamics of impact inequality depending on alternative growth rate of global GDP and pace of conservation of bio-resources and bio-capacity, while the ultimate choice will have to be left to be political. In any case the conversion of impact inequality into equality would require massive investment in the coming days in science and technology, research and development for both restructuring the economy and conservation of resources and raising productivity of our ecosystems. Such measures will have to include measures for conservation of biodiversity by containing all fragmentation of ecosystems and controlling the impact of nonlinearity in their behavior. These are supposed to be required to address the problems of health of both the humans and that of the ecosystems of biosphere.

CHALLENGES OF MEETING THE EXISTENTIAL CRISIS: ECONOMIC IMPACT OF COVID-19 AND FUTURE OPPORTUNITIES FOR SUSTAINABILITY

The different countries of the world are now facing a huge challenge of sustainability because of the existential problem arising from the highly infectious nature of the fast spreading disease COVID-19. As the virus from the zoonotic source spread among humans at exponential rate through contacts and droplets once the virus has jumped on to a new host of human body. An immediate measure for the control of the spread has required social distancing among people and lock down of the society ensuring cessation of all movements of people, all assemblages and therefore that of all production or economic activities. Such measures have led everywhere to loss of employment and income causing in turn disruption of demand for goods and services, on the one hand and disruption of the supply chain due to stoppage of production activities on the other. The two disruptions further have caused in turn disruption of capital market which is plagued by various types of uncertainties. The economies are thus pushed into recession due to fall in effective demand, investments and growth all round propagated through inter-sectoral input output linkages, caused by such disturbances and turmoil. The policy for saving life thus inevitably leads to a situation of trade-off between life and livelihood or economic survival of the people. However, the purpose of such measures of physical control of normal human activities is supposed to be short run in nature. They are supposed to be meant for buying time for the preparedness of the health and social service infrastructure to cope with the unprecedented and unexpected fast growing demand for their services. These included, facilities on a large scale of testing infection, discovering and introducing vaccine for the viral disease, treatment in hospital, supply of medicines and personal protection equipment (like masks, gloves, face shields, lab overcoats, etc.), life support oxygen supply equipment, ventilators, etc.

The suddenness of the outbreak of the disease as it first broke out in most of the countries warranted such drastic measure of command and control resulting in huge economic loss. IMF has recently projected -3% growth for the global economy for 2020. This describes a far worse situation than that of 2009 financial crisis. While for the advanced countries the growth rate may slump to

Table4: Impact of Lockdown due to pandemic sector-wise and overall GVA

			Post-pandemic 2020-21	
		Income loss factor Yearly basis	% Loss over 2020-21 pre-pandemic	Growth over 2019-20 (%)
1	Food grains	0.0231	-2.3	0.1
2	other crops	0.0385	-3.8	-0.8
3	Allied Agriculture	0.0462	-4.6	-1.3
4	Natural Resources	0.0923	-9.2	-5.6
5	Manufacturing	0.1308	-13.1	-9.3
6	Construction	0.1462	-14.6	-10.8
7	Trade, hotels, transport and communication	0.1077	-10.8	-4.5
8	Other services (including public administration and defence)	0.0462	-4.6	2.5
	GVA		-8	-2.7

Source: Panda (2020)

-6%, the developing countries may experience a growth of -1% in the same year 2020. However, if China is excluded, the growth of developing economies together is likely to slump to -2.2% as per IMF projections.

For the Indian economy the impact of lock down of 8 weeks from 25 March, 2020 as analyzed by Panda (2020) was estimated to cause an overall loss of income of 8% compared to pre-pandemic 2020-21 income level. This implies a slump of the growth rate of 2020-21 over 2019- 20 to be - 2.7%.per annum. At the sectoral level the loss has varied from 2.3% for food-grains to 14.6% for construction. Table 3 gives broad sector-wise income loss factor on yearly basis and both the estimates of loss of post pandemic income over pre-pandemic one for 2020-21 and estimates of loss of post pandemic income of 2020-21 over 2019-20 as estimated by Panda using the latest multi-sector input – output model for the Indian economy, both the estimates of losses being estimated on annual basis (See Panda 2020). The Table 4 shows that natural resource extraction, manufacturing industry, construction and trade, transport and hospitality sector, are the most adversely affected sectors in India suffering percentage losses of 9.2, 13.1, 14.6 and 10.8 respectively.

So far as impact of lockdown in India is concerned, it is important to mention about the impact on labor, particularly the migrant laborers who have been the worst sufferer. In India there existed interstate migrant population of 5.47 crores as per 2011 census. Of this migrant population, migrant laborers (including petty self-employmed ones) are engaged in unorganized sector with subsistence income and no social security. They live mostly in slums or slum like living condition, entire family mostly living in one room accommodation with poor water supply and sanitary condition. These people became very vulnerable to all infectious diseases like COVID-19. However, with the announcement of lockdown, these laborers lost almost instantaneously their jobs, income and their rented accommodation as they were immediately evicted by their landlords. These laborers with their family members were forced to return to their homes in different states, while the government had no planning and preparedness to facilitate the return of these people. The Central government announced lockdown thoughtlessly at 4 hours' notice, without having any preparedness of transportation of such huge migrant population which is estimated by the World Bank to be 40 million who were left in the lurch initially (Economic Times June 25-26, 2020). As a result of such desperate situation such people began to walk or take a ride by truck or any kind of motorized vehicle paying exorbitant charge in order to return to their respective homes. Many of them suffered from hunger and exhaustion and fell ill or collapsed to death on the way as reported widely in the media. The government was ultimately forced to arrange buses and trains for transportation of these migrant laborers because of adverse media reporting revealing the truth. However, these migrants had to be herded into these transports throwing the social distancing norms to the wind. This resulted in many of these home returning migrants reaching their destination with COVID-19 infections. This has aggravated the disease situation in the destination home state, although the situation varied across the states.

WHAT IS THE WAY AHEAD?

First of all, how deep or prolonged is going to be the current economic depression caused by the pandemic of COVID-19. This well depend on two factors:

1. Exit policies of lockdown of the countries depending on their assessment of trade-off between life and livelihood.
2. What kind of fiscal and monetary incentives or reliefs are provided by the government of the concerned countries? As we are aware the governments of Japan, US, China Sweden, Germany and India among others have offered financial packages of relief amounting to 21.1%, 13%, 12%, 10.7% and 10% of GDP respectively.

These reliefs would be helpful for recoveries of the economies by alleviating suffering of the losing the jobs by the common people in the pandemic and incentivizing the business to restart the operations and spending both on current and capital account.

However, as the social security, health and social infrastructural conditions are much worse in the developing countries than the advanced industrialized ones, the overall human development impact of the current pandemic in spite of such relief packages would be worse for the former. This would underline the need for vast improvement of social security condition of the Indian common people and of health and other social infrastructural condition by raising the share of spending on these sectors as a share of GDP, to be able to better withstand the impact of any such extreme event in future. These issues have been long neglected as the business as usual suffering of common people due to poverty and health insecurity is politically accepted to be normal in India in spite of our political democracy. This pandemic has revealed our weaknesses and make the improvements mentioned as imperative for the survival of our people and for the improvement of both robustness and resilience of our health and socio economic system

in the event of external shocks in future from extreme natural and disease related event.

We in India and people in many other countries are still in the midst of the pandemic COVID-19. Table 5 shows how the growth of confirmed cases of infection per day has risen during the period 25th march to 10th May, to the period 10th may to 8th June and further to the period 8th June to 15th July 2020 for the different states in India. It shows while the growth of cases per day for all India was 1371.5 between 25 March and 10 May, it rose to 6309.7 during the period from 10th May and 8th June and further to 18636.5 during the period from 8th June to 15th July, 2020. As the trend of infection and that of fatality are still on the rise we are confronted with hard choice between that of saving life by continuing with lockdown and easing lockdown to save livelihood and income of the poor.

The trade-off between lives and livelihood poses a problem of hard choice to for the policy makers as well as private households in the current pandemic situation. Lockdown is gradually being eased in Indian cities though it had initially helped to contain the severely infectious virus to some extent and provide time to prepare the public health system to tackle the

Table 5. Per day growth of infection across states during 25th March to 10th May and during 10th May to 8th June, 2020 and during 8th June, 2020 to 15th July, 2020

	Per day growth in total confirmed cases of COVID-19 infections		
	Between 25th March, 2020 and 10th May, 2020	Between 10th May, 2020 and 8th June, 2020	Between 8th June, 2020 and 15th July, 2020
Andaman & Nicobar Island	0.7	0.0	3.6
Andhra Pradesh	41.8	89.0	770.5
Arunachal Pradesh	0.0	1.6	11.2
Assam	1.4	80.5	416.5
Bihar	12.8	149.1	388.4
Chandigarh	3.5	4.8	7.9
Chhattisgarh	1.3	29.8	93.4
Delhi	141.6	728.0	2370.1
Goa	0.2	9.0	67.2
Gujarat	168.7	406.8	649.9
Haryana	14.4	113.0	504.8
Himachal Pradesh	1.0	12.1	24.6
Jammu & Kashmir	17.7	90.7	208.3
Jharkhand	3.4	29.1	83.5
Karnataka	16.4	152.4	1050.4
Kerala	8.8	44.9	192.5
Madhya Pradesh	78.3	193.6	264.2
Maharashtra	437.0	2163.4	4991.8
Manipur	0.0	5.3	40.9
Meghalaya	0.3	0.7	7.7
Mizoram	0.0	0.8	5.8
Nagaland	0.0	3.7	21.3
Odisha	6.3	85.8	310.8
Puducherry	0.2	3.1	38.7
Punjab	37.7	26.0	162.1
Rajasthan	79.9	228.4	411.9
Sikkim	0.0	0.2	5.5
Tamil Nadu	141.7	814.4	3166.8
Telangana	41.1	54.5	925.6
Tripura	2.9	21.1	38.5
Uttar Pradesh	72.5	219.3	810.6
Uttarakhand	1.4	42.6	64.4
West Bengal	38.6	205.2	678.4
All-India	1371.4	6309.7	18636.5

Source: Author's estimation from data collected from Ministry of Health and Family Welfare, Government of India

public health crisis. Lifting of lockdown increases the probability of mass infection due to increased contacts among people traveling for jobs and for other essential needs. But majority of Indian workforce are engaged in informal sector or are engaged as informal workers in formal sector, and majority of them do not have any social security. Many of them have already exhausted their savings to sustain during the lockdown. To address these issues, Indian government is going forward with phase-wise reopening of the economy as decided by the state governments depending on the assessment of the local situation.

One source of problem of easing lockdown is that the asymptomatic people may infect many other test-negative people because of contacts in public places. Besides, social distancing in a densely populated country becomes almost impossible in crowded market place, public transport or in urban slums which are the habitats of the poor in a country like India. The inevitable results of such easing of lockdown are rise in both the rate of infections and the rate of fatality as being currently experienced in India. The rate of fatality however varies across age group depending also on the person's co-morbidity, being higher for older age group compared to the younger ones. Thus easing lock down in the interest of saving livelihood and income would involve cost of early death among aged population which can be estimated as per the statistical value of life which would be lost for deaths at the different ages. The loss of asset value of such lives and their equivalent income loss in perpetuity as per the prevailing interest rate can thus be estimated and compared with total income saved due to easing of lock down for arriving at the trade-off between life of the aged ones and livelihood and income of the people for policy decision. However, such methodology of benefit –cost analysis would appear to be highly reactionary in nature as it amounts to the denial of equal right to life to everyone irrespective of age. The society is thus confronted with hard choice regarding timing of easing lockdown and must realize the discovery of vaccine, medicine and treatment for COVID-19 for saving life is of supreme importance along with learning to live with full are partial lockdown following strict rules of precautions and preventions irrespective of any cost benefit analysis.

In order to reduce the risk of resurgence of cases of infection in large numbers, one may consider policy option in respect of transport, working norms and institutional practices. While social distancing is being used one major way of limiting the spread of the disease when lockdown is eased, maintaining such distancing norm during local or intercity travel in overpopulated country like India, is almost infeasible as this would require several times increase in the number of road transport vehicles, or in that of passenger rakes in rail transport. Air transport of passenger will also require much larger fleet of airplanes to carry the same number of passengers. This would require huge capital investment for the expansion of passenger carrying capacity by any of these transport mode maintaining the social distancing norms, and cause much larger congestion in the traffic movement on ground and Greenhouse gas emissions.

However, one major way of resolving the problem would be to reduce the requirement of passenger travel itself for producing the same GDP and the same level of consumer satisfaction of the people by working from home online or by staggering timing of office hour to reduce the pressure on urban transport system. The systems of work, travel and transport are already adjusting themselves in different countries by the introduction of on line work, use of more of digitalization and automation in the delivery of work or services of various kinds including material goods, etc.

CONCLUDING REMARKS

The preceding sections of this paper have pointed out first of all the fundamental source of the problem of pandemic COVID- 19 and other extreme natural events as India is experiencing is the disruption of ecological balance between human appropriation of resources of the biosphere and bio-capacity of our ecosystem. This has expressed itself in the forms of biodiversity loss and climate change – which are again interactive. These events posed a challenge to us and we are confronted with a tough choice today between life and livelihood, and between economic growth and halting erosion of environmental capital stock of biosphere. This further takes us to the fundamental question: how do we reduce the requirement of growth of scale of our economy to operate within the safe limits of the biospheric system without affecting the social well-being. This, in other words, asks for such change in preference structure of the people of society and a redistribution of their income and wealth that the resulting aggregate demand can limit the demand for biospheric resources within the bound of regenerative capacity of the biosphere (Dasgupta interim report 2020). The feasibility of such change would depend on our sense of values and ethics concerning growth, well-being and sustenance of other species. These would imply our long run policies to ensure adjustment of our system as described by the population with demographic characteristics and reproductive and

other health conditions on the one hand, and the scale, composition, technology and the architectural design of human organization of economic activities on the other.

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