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Extreme Level of CO_2 Accumulation into the Atmosphere Due to the Unequal Global Carbon Emission and Sequestration

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Abstract Global total CO_2 emission and sequestration are being analysed from 1960 to 2029 reports interpreted from DEP, DOE, IPCC, CFC, CDIAC, IEA, UNEP, NOAA, and NASA. Consequently, these reports have been transcribed into each 10-year-period data set by using MATLAB software to accurately calculate the decadal emission and sequestration rate of total CO_2 within the world. Then, these data were further analysed to determine the final annual increasing rate (yr $^{-1}$) of CO_2 accumulation into the atmosphere. The study revealed that total CO_2 emissions throughout the world since the 1960s have been increasing rapidly and in the recent year the net CO_2 increasing rate is 2.11% annually. If the current annual CO_2 growth rate is not copped now, the atmospheric CO_2 accumulation shall indeed reach at a toxic level of 1200 ppm concentration of CO_2 into the atmosphere in 53 years. Consequently, the entire human race will face severe breathing problems due to the toxic level of CO_2 presence in the air which indeed will create a serious environmental vulnerability to live mankind on Earth comfortably.

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1 Introduction

Since 1960s, massive development of industrialisation and the misuse of the natural resources throughout the world quicken the accumulation of atmospheric CO_2 concentration heavily which certainly will be dangerous for mankind to take fresh breath in the near future (Bauer et al., 2013; Betts et al., 2016; Davis & Caldeira, 2010). Several studies revealed that currently accumulation of CO_2 into the atmosphere is 400 ppm, and it is increasing in such a rapid rate that it will reach soon at the toxic level which will result in human being to have severe respiratory problems and possibly many people throughout the world will die (Cetin & Sevik, 2016; Erb et al., 2013; Li et al., 2016). A recent study by Sert et al. (2019) and Sevik et al. (2020) revealed that air pollution has become a problem on a global scale and poses a significant risk in terms of human health and natural ecosystems. Another study by Cetin, (2016), Cetin et al., (2019) discovered that air pollution is one of the dreadful problems around the world especially in the cities, and people are getting various health problems and even thousands of people are dying every year affected by this air pollution. Recent studies by Krapivin and Varotsos (2016), Krapivin et al. (2017), and Varotsos et al. (2020) suggested that major natural and man-made climate changes will result tremendous increasing of atmospheric CO_2 by 2150 which will influence on the global cycles of greenhouse gases extensively for the survival of the planet Earth. So, it is time without a doubt to make the global environment green by reducing CO_2 emissions which will confirm the versatility, adaptability, and manageability of our mother Earth, which will not result in maladjustment simultaneously, but will be presentable as a sustainable world for our future generation to take a fresh breath. Thus, in the research, a detail calculation of global CO_2 emission from all sources on Earth and sequestration of CO_2 by all sinks on this planet have been estimated to evaluate the net increasing rate of CO_2 into the atmosphere to give an advance warning to the mankind for forthcoming environmental vulnerability due to the heavy accumulation of CO_2 into the atmosphere. Simply, this study will help the global scientific community, policy makers, and leaders to take this forthcoming danger seriously to mitigate global CO_2 immediately to console the forthcoming deadly respiratory problem for mankind on Earth.

2 Methods and Simulation

2.1 *CO_2 Emissions*

The decadal increasing rate in CO_2 emissions due to all industrial developments globally was estimated from the difference between consecutive decades from the period 1960s, 1970s, 1980s, 1990s, 2000s, 2010s, and 2020s, and then, it was converted into yearly growth rate divided by past year emission to the current year emissions by using the following equation:

$$\mathrm{FF} = \left[\frac{E_{\mathrm{FF}(t_{0+1})} - E_{\mathrm{FF}(t_0)}}{E_{\mathrm{FF}(t_0)}}\right] \times 100\%\mathrm{year}^{-1} \tag{1}$$

Here, this simple calculation is being analysed to determine per year CO_2 emission increasing rate. To precisely estimate the CO_2 increasing rate considering each decadal period, a leap-year factor is also being applied to determine net yearly increasing rate of CO_2 (E_{Ff}) by using its logarithm equal to the below equation:

$$\mathrm{Ff} = \frac{1}{E_{\mathrm{FF}}} \frac{d\left(\ln E_{\mathrm{FF}}\right)}{dt} \tag{2}$$

Here, the net CO_2 emission increasing rates have been calculated accounting multi-decadal time scales by integrating a non-linear function into $\ln(E_{\mathrm{FF}})$ in Eq. (2) to calculate eventually yearly increasing rate of CO_2 into the atmosphere (Achard et al., 2014; Canadell et al., 2007; Houghton, 2007). Thus, the algorithm of E_{FF} of this equation is being fitted into MATLAB algorithm E_{FF} to confirm the precise increasing rate of CO_2 yearly.

Similarly, the CO_2 emissions calculated here (E_{LUC}) due to the misuse of all natural resources throughout the world were calculated by implementing dynamic global environmental modelling (DGVM) simulations in MATLAB considering the difference between two consecutive decadal periods of 1960s, 1970s, 1980s, 1990s, 2000s, 2010s, and 2020s (Ballantyne et al., 2012; Morimoto et al., 2021; Stephens et al., 2007). Then, a time series is being implemented in this simulation by allocating the dynamic emission of CO_2 due to the misuse of all natural resources throughout the world within two consecutive years, and then, it was converted into yearly growth rate divided by past year emission to the current year emissions by using the following equation:

$$\mathrm{LUC} = \left[\frac{E_{\mathrm{LUC}(t_{0+1})} - E_{\mathrm{LUC}(t_0)}}{E_{\mathrm{LUC}(t_0)}}\right] \times 100\%\mathrm{year}^{-1} \tag{3}$$

Here, the equation is being calculated in yearly CO_2 emissions growth rate (Earles et al., 2012; Jain et al., 2013; Stephens et al., 2007). However, to precisely determine the increasing rate of CO_2 in multiple decades, a leap-year factor is also being applied to ensure the net yearly increasing rate of carbon dioxide (E_{LUC}) which is expressed by the following equation:

$$\mathrm{Luc} = \frac{1}{E_{\mathrm{LUC}}} \frac{d\left(\ln E_{\mathrm{LUC}}\right)}{dt} \tag{4}$$

Here, the CO_2 emission increasing rates have been estimated corresponding to all decadal time scales by applying a non-linear function in $\ln(E_{\mathrm{LUC}})$ in Eq. (4) to determine annual CO_2 emission into the atmosphere (Prietzel et al., 2016; Schwietzke et al., 2016). Thus, the algorithm of E_{FF} is being integrated into

MATLAB to confirm the precise emission rate of CO_2 from misuses of all natural resources.

Finally, the global total CO_2 emission from all industrial developments and misuse of natural resources per year has been calculated by combing all four equations (Eqs. 1, 2, 3, and 4) as follows:

$$FL = \left[\frac{E_{FF(t_{0+1})} - E_{FF(t_0)}}{E_{FF(t_0)}}\right] \times 100\% year^{-1} + \frac{1}{E_{FF}}\frac{d(lnE_{FF})}{dt} + \left[\frac{E_{LUC(t_{0+1})} - E_{LUC(t_0)}}{E_{LUC(t_0)}}\right] \times 100\% year^{-1} + \frac{1}{E_{LUC}}\frac{d(lnE_{LUC})}{dt} \quad (5)$$

Thereafter, the global CO_2 sequestration considering (1) ocean sink and (2) terrestrial sink available throughout the world has been calculated from 1960 to 2029 by conducting a 10-year period of experiment on each data set and then converted it into the time period for an average annual rate.

2.2 *CO_2 Sink*

Consequently, the CO_2 sequestered by the ocean is being calculated for the past years and the next years from the decadal set of 1960s, 1970s, 1980s, 1990s, 2000s, 2010s, and 2020s by implementing oceans' carbon sink cycle models (Hossain, 2017; Liu et al., 2015). This approach is being implemented to accurately analyse the physio-biological processes of global oceans directly involved in CO_2 sequestration by the ocean surfaces and its fauna (Chevallier, 2015; Hossain, 2016). Thus, the oceans' CO_2 sink is being determined accurately by dividing the individual yearly values with the previous year's value; therefore, the oceanic CO_2 sequestration per year (t) in GtC yr^{-1} is being calculated as follows:

$$S_{\mathrm{OCEAN}}(t) = \frac{1}{n}\sum_{m=1}^{m=n} \frac{S^m_{\mathrm{OCEAN}}(t)}{S^m_{\mathrm{OCEAN}^{(t10-t1)}}} \quad (6)$$

Here n is the number of oceans; m is the factor involving CO_2 sequestration; and t represents the period.

Then, the absorption of CO_2 per year by terrestrial vegetation and the Earth is also being determined to determine the total CO_2 sequestration by land (S_{LAND}) similarly from the decadal set of 1960s, 1970s, 1980s, 1990s, 2000s, 2010s, and 2020s and convert it into annual rate. Here, the net CO_2 sink by land is being calculated as follows:

$$S_{\mathrm{LAND}} = E_{\mathrm{FF}} + E_{\mathrm{LUC}} - \left(G_{\mathrm{ATM}} + S_{\mathrm{OCEAN}}\right) \quad (7)$$

Here, S_{LAND} is calculated from the remainder of the estimates where G_{ATM} is the present CO_2 into the atmosphere, (E_{FF}) is the carbon from industrial development, and E_{LUC} is the CO_2 from the misuse of all natural resources throughout the world (Ballantyne et al., 2012; Stephens et al., 2007).

Then, the computation of S_{LAND} in Eq. (7) is being utilised to determine E_{LUC} by subtracting $\left(G_{\mathrm{ATM}} + S_{\mathrm{OCEAN}}\right)$ CO_2.

Subsequently, the total CO_2 sequestration in a year period has been calculated by combing these two equations (Eqs. 6 and 7) as follows:

$$S_{OCEAN}(t) + S_{LAND} = \frac{1}{n}\sum_{m=1}^{m=n} \frac{S^m_{OCEAN}(t)}{S^m_{OCEAN^{(t10-t1)}}}\Bigg) + \left(E_{FF} + E_{LUC} - \left(G_{ATM} + S_{OCEAN}\right)\right. \quad (8)$$

Atmospheric CO_2 Concentration (G_{ATM}) Increasing Rate.

Finally, the net yearly increasing rate of the atmospheric CO_2 concentration is being determined yearly from the variation of the total CO_2 emission and total CO_2 sequestration each year.

3 Results and Discussion

3.1 *CO_2 Emission*

The average global CO_2 emissions from 1960 to 2029 during this time scale showed that total CO_2 emissions from combined industrial development and the misuse of all natural resources throughout the world are at an annual average of 1.7 GtC yr^{-1} of 1.7 ± 0.7 GtC yr^{-1} per decade in the 1960s (1960–1969); annual average of 2.2 GtC yr^{-1} of 1.7 ± 0.8 GtC yr^{-1} per decade in the 1970s (1970–1979); annual average of 1.5 GtC yr^{-1} of 1.6 ± 0.8 GtC yr^{-1} per decade in the 1980s (1980–1989); annual average of 2.45 GtC yr^{-1} of 2.6 ± 0.8 GtC yr^{-1} per decade in the 1990s (1990–1999); annual average of 2.45 GtC yr^{-1} of 2.6 ± 0.8 GtC yr^{-1} per decade in the 2000s (2000–2009); and annual average of 3.26 GtC yr^{-1} of 3.26 ± 0.5 GtC yr^{-1} per decade in the 2010s (2010–2019) and expected to be increased to annual average of 3.26 GtC yr^{-1} of 3.26 ± 0.5 GtC yr^{-1} per decade in the 2020s (2020–2029) (Table 1).

3.2 *CO_2 Sink*

Subsequently, the results of CO_2 sequestration by ocean and the terrestrial vegetation and land suggested that the average global CO_2 sink from 1960 to 2029 during this time scale showed that total CO_2 emissions from combined industrial development and the misuse of all natural resources throughout the world are at an annual average of 1.5 GtC yr^{-1} of 1.5 ± 0.2 GtC yr^{-1} per decade in the 1960s (1960–1969); annual average of 1.3 GtC yr^{-1} of 1.3 ± 0.5 GtC yr^{-1} per decade in the 1970s (1970–1979); annual average of 1.4 GtC yr^{-1} of 1.4 ± 0.6 GtC yr^{-1} per decade in the 1980s (1980–1989); annual average of 1.4 GtC yr^{-1} of 1.6 ± 0.4 GtC yr^{-1} per decade in the 1990s (1990–1999); annual average of 1.15 GtC yr^{-1} of 1.15 ± 0.5 GtC yr^{-1} per decade in the 2000s (2000–2009); and annual average of 1.15 GtC yr^{-1} of 1.15 ± 0.5 GtC yr^{-1} per decade in the 2010s (2010–2019) and expected to increase to annual average of 1.15 GtC yr^{-1} of 1.15 ± 0.5 GtC yr^{-1} per decade in the 2020s (2020–2029) (Table 1).

3.3 Atmospheric CO_2 Concentration (G_{ATM}) Increasing Rate

Then, the rate of growth of the atmospheric CO_2 concentration is being calculated by comparing the decadal and individual annual values for 10 years periodical set which suggested that the average global CO_2 annual growth from 1960 to 2029 is 0.2% at the decade 1960s; 0.9% at the decade 1970s; 0.1% at the decade 1980s; 1.15% at the decade 1990s; 1.3% at the decade 2000s; 2.11% at the decade 2010s; and expected to be 2.11% at the decade 2020s. The projected growth rate of atmospheric CO_2 concentration presumably suggested that the increased rate of CO_2 will remain the same as 2.11% per year for next several decades if we do not curb this acceleration of CO_2 emissions (Table 1).

The current CO_2 concentration into the atmosphere is 400 ppm and is growing at a rate of 2.11% per year; thus, the following equations confirmed that it will attain at a toxic level of 1200 ppm in 53 years.

$$1200 = 400(1 + .0211)^{\mathrm{Year}} \tag{9}$$

$$3 = (1 + .0211)^{\mathrm{Year}} \tag{10}$$

Table 1 The results from DGVM simulation in MATLAB, implemented from the data of DEP, DOE, IPCC, CFC, CDIAC, IEA, UNEP, NOAA, and NASA to confirm the yearly increasing rate of atmospheric CO_2 (%). The results described the variation of the total CO_2 emissions from industrial development and misuse of all natural resources throughout the world and the total CO_2 sink (ocean and land) from the years 1960–1969, 1970–1979, 1980–1989, 1990–1999, and 2000–2009, 2010–2019, and 2020–2029 shown in GtC yr^{-1}

Mean (GtC yr^{-1})	1960–1969	1970–1979	1980–1989	1990–1999	2000–2009	2010–1019	2020–2029
Total CO_2 emission (industrial development and misuse of natural resources)							
DGVM simulations and the mean average data of DEP, DOE, IPCC, CFC, CDIAC, IEA, UNEP, NOAA, and NASA for each decadal period of CO_2 emissions	1.7 ± 0.7	1.7 ± 0.8	1.6 ± 0.8	2.6 ± 0.8	2.6 ± 0.8	3.26 ± 0.5	3.26 ± 0.5
Net CO_2 emission rate (%) per year	1.7	2.2	1.5	2.45	2.45	3.26	3.26
Total CO_2 sink (ocean and terrestrial vegetation and land)							
DGVM simulations and the mean average data of DEP, DOE, IPCC, CFC, CDIAC, IEA, UNEP, NOAA, and NASA for each decadal period of CO_2 sequestration	1.5 ± 0.5	1.3 ± 0.5	1.4 ± 0.6	1.6 ± 0.4	1.15 ± 0.5	1.15 ± 0.5	1.0 ± 0.5
Net CO_2 sequestration rate (%) per year	1.5	1.3	1.4	1.4	1.15	1.15	1.15
Annual increasing rate of atmospheric CO_2 (%)							
G_{ATM}	0.2	0.9	0.1	1.05	1.3	2.11	2.11

$$\text{Log}3 = \text{YearLog}(1.0211) \tag{11}$$

$$\text{Year} = 52.61 = 53(\text{roundfigure}) \tag{12}$$

Consequently, all human beings on earth will be in serious breathing problem due to the toxic level of CO_2 into the atmosphere. Simply, it is an urgent demand to reduce the CO_2 emission globally to mitigate the forthcoming deadly breading problem for mankind as well as secure a better planet for our next generation.

4 Conclusion

The total global CO_2 emissions due to the industrial development and the misuse of all natural resources throughout the world estimated for the past several decades as well as total CO_2 sink by ocean and land were calculated to determine the increasing rate in CO_2 into the atmosphere each year. The yearly increasing rate of the atmospheric CO_2 accumulation over the last several years was confirmed by simulated estimate which revealed that it is increasing at a rate of 2.11% yearly. If the current annual CO_2 growth rate is not copped now, the atmospheric CO_2 accumulation shall indeed reach at a toxic level of 1200 ppm in 53 years which will result in the entire human race to face severe respiratory problem throughout the world.

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Author Contribution Md. Faruque Hossain is the sole author for the paper. He has contributed 100% for conducting research, collecting data, and writing papers.

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Data Availability The data sets used in this study are available from the corresponding author on reasonable request except for data that is subject to third party restrictions.

Declarations

Competing Interests The author declares no competing interests.

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