Global Warming – A Threat to Human Survival

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Abstract

Nature has the self-curing abilities that nullify any external intervention into the environment that can disturb ecological balance. But when human intervention exceeds beyond a limit, arising due to anthropogenic intervention into the environment, it becomes difficult for the nature to absorb. The Global Warming is the outcome to this. The exponential rise in global average temperature is threatening to human survival, if not controlled by the end of the century. International conventions such as UNFCCC, COP26 have made many declarations, such as restoration and enhancement in green coverage, replacement of fossil with renewable or other low carbon emitting fuel, improving energy efficiency and much other technological advancement. Hydrogen economy is also moving on fast track. Government of India has announced many missions and scheme to reduce emission such as Solar and Wind, National Hydrogen Mission, Biofuel, Coal Gasification, and encouraging through many incentives and other financial packages. Global environmental awareness and actions taken, have been increasing to protect it and meet the goal of Paris Conventions 2015 on climate change, that stipulates to restrict the rise in global temperature by the end of this century, below 2 degree C, with reference to pre industrial level (1860-80). But still a lot more need to be done on the fast track.

Jharkhand state of India that stores 40% of national minerals reserve and produces maximum coal, can contribute immensely in meeting the national target, announced by our Prime Minister in COP26 under " Panchamrit". Exploitation of Coal Bed Methane, Coal Gasification, Coal to Chemicals, are the ways and means through which the carbon emission can be reduced to a great extent with optimal utilization of coal that the nation shares 9.5% of global reserve. Direct burning of coal in the furnace needs to be avoided to the extent possible that emits highest carbon of all other fossil.

The author has put his views on the global awareness created actions that have been taken and need to be taken to save the planet, which otherwise is threatening to human survival.

Key words: Global warming, carbon emission, global awareness, renewable energy

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Introduction

It is essential to have a healthy environment for the progress and prosperity of humankinds on this planet. Nature has ability to correct any external intervention to the environment, that causes any ecological imbalance, by herself. Salinity of sea water, oxygen content of atmosphere, global temperature, hydrosphere, and all other environmental parameters are controlled by nature for the survival of lives on the planet. But, human intervention, particularly due to rapid industrialization, has injured the environment so deeply that it has become difficult for Mother Nature to correct it by herself.

Nature and Gaia Hypothesis - The Gaia Hypothesis proposed by James Lovelock (1972) suggests that living organisms on the planet interact with their surrounding inorganic environment to form a synergetic and self-regulating system that maintains the climatic and biochemical conditions of the planet that in turn, makes the life on the earth possible. This postulate of Gaia theory is based on the fact that the biosphere and the evolution of organisms, affect the stability of global temperature, salinity of seawater and other environmental variables. For instance, even though the luminosity of the Sun, the earth's heat source, has increased about 30% since life began almost four billion years ago, the living system has reacted to maintain temperatures at a level suitable for life on this planet. Cloud formation over the open ocean is almost entirely a function of oceanic algae that emits sulphur molecules as a waste metabolite, which becomes condensation nuclei for rain. Clouds, in turn, help regulate surface temperatures. Why 21% of oxygen in earth atmosphere, why atmosphere is not mainly carbon dioxide, why oceans are not more saline, all these are well explained through biological activity on the earth. In other words, we can say that the balance between biosphere, hydrosphere and atmosphere is maintained by nature itself that in turn maintains the life on it.

But there is limit of any external intervention that nature can correct herself and beyond which the balance or equilibrium between biosphere, hydrosphere and atmosphere is offset or disturbed. This offset changes the climatic conditions on the planet, and Global Warming is the consequence of this. Rising of global temperature and sea level, floods, draughts, heat waves are all the consequences of imbalance in environment, consisting of biosphere, hydrosphere, and atmosphere. All these have happened due to excessive human interventions that nature could not correct herself.

The natural emission of CO2 has been estimated to be 770 billion tons per annum, out of which major parts 43% come from ocean, in order of 330 billion tons per annum. Plant and animal respiration make 28.5% , 220 billion tons per annum. Soil respiration and decomposition of dead organic materials make other 28.5%, 220 billion tons per annum. The same quantity of CO2 is absorbed by nature keeping CO2 concentration in atmosphere in balance. But excessive anthropogenic emission

upset this balance adding extra CO2 in the atmosphere without removing, which accumulates in long run. Global energy related CO2 emission is as high as 38 billion tons per annum and India shares around 6.5% of this.

Fossil Fuels - Fossil fuel combustion is the main and major factor that has offset the balance in environment. Fossil fuel combustion emits mainly carbon dioxide and sulphur, whereas other industries emit other pollutants such as sulphur and nitrogen oxides, methane and other high ozone depleting potential gases.

Carbon Dioxide (CO2) is the main component that has affected the global warming. The heat radiation from Sun, falling on the earth is mostly absorbed by earth, around 70%, and remaining 30% is reflected. Excessive CO2 in the atmosphere absorbs this heat radiation, not letting the heat to bounce back, as a result the atmospheric temperature rises.

Even a small fraction of rise in atmospheric temperature makes a big impact in the climatic condition of the planet. The European Geosciences Union published a study in April 2016 that examined the impact of a 1.5- degree Celsius vs. a 2.0-degree Celsius temperature increase, by the end of the century, given what we know so far about how climate works. It found that the jump from 1.5 to 2 degrees increase - a third more of an increase - raises the impact on the environment, by about that same fraction, very roughly, on most of the phenomena the study covered. Heat waves would last around a third longer, rainstorms would be about a third more intense, the increase in sea level would be approximately that much higher and the percentage of tropical coral reefs at risk of severe degradation would be roughly that much greater.

Keelings Curve - Global measurement of CO2 started scientifically in 1958. Prior to this, the measurement had been on adhoc basis. Charles David Keelings of Scripps Institute of Oceanography, San Diego started this measurement at different strategic locations on day and night, on regular basis and found that the variation in atmospheric CO2 concentration is cyclic and depends upon day/night due to plant respiration and photosynthesis, and seasonal variations during plants decay in winter and growth in summer. This curve plotted for atmospheric CO^2 concentration against timeline, starting from 1960, is called Keelings Curve. It also correlated with industrialization and fossil fuel burning and found that there is exponential rise in atmospheric CO_2, 1970 onwards when fossil fuel combustion has been at the peak. CO_2 concentration in atmosphere has risen from 315 ppm at 1960s to 415 in 2020s. The Keeling Curve is shown below in Fig-1.

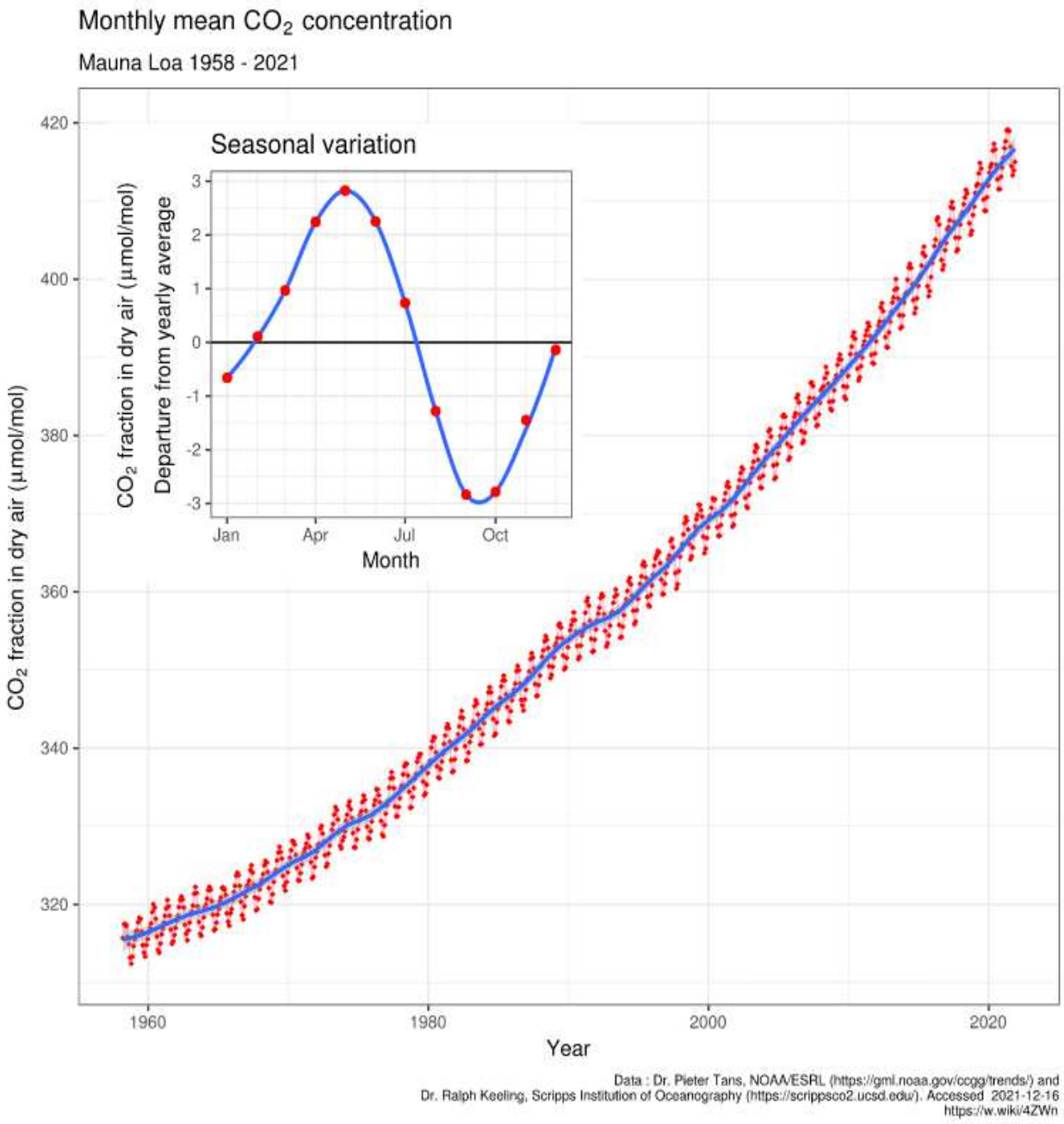

Fig-1. Monthly mean CO_2 concentration

Average Global Temperature during pre-industrialization period (1860-1890) had been sub-zero. It rose at 0.14-degree F per decade initially, but since last forty years it rose at 0.32-degree F, more than the double the rate. The Global average temperatures, measured by different agencies are shown below in Fig-2.

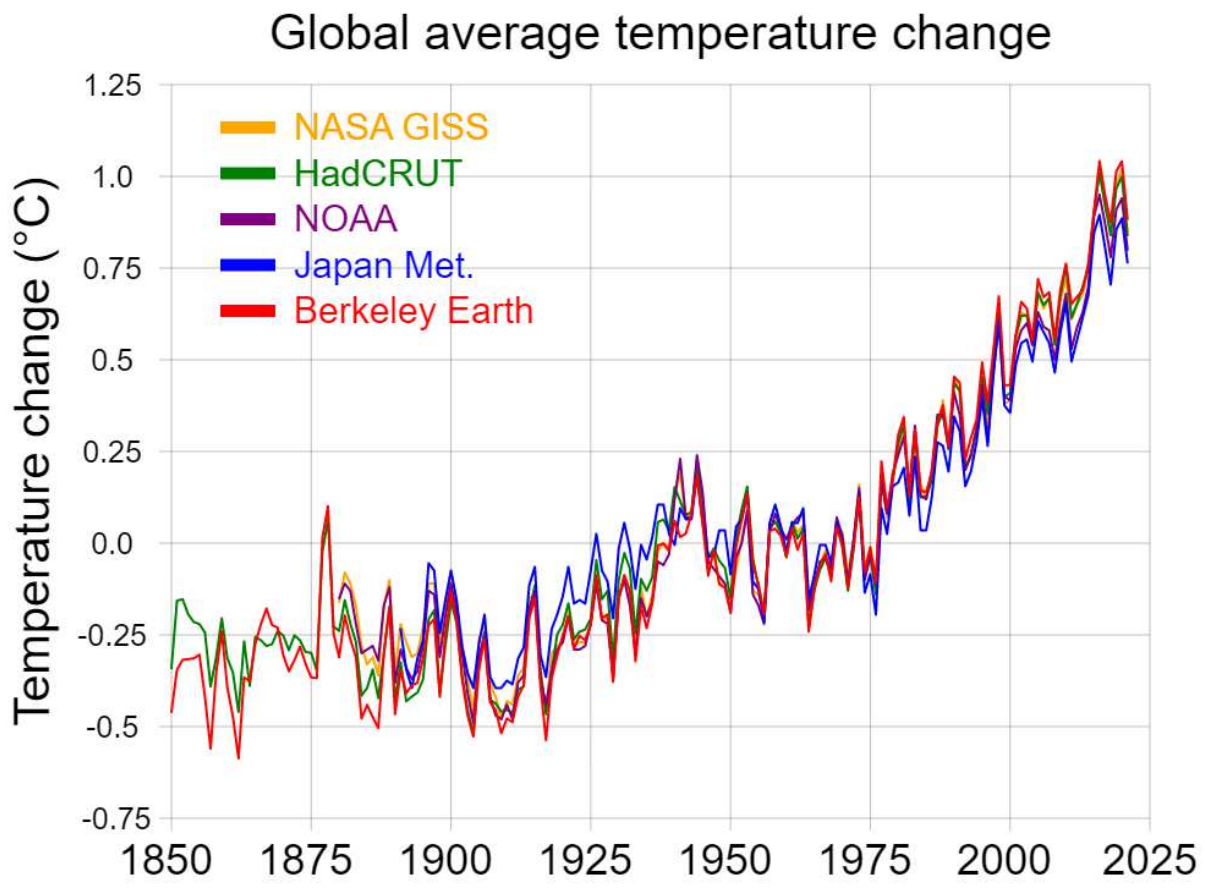

Fig-2.Global average temperature change

Kyoto and Paris Conventions on Climate Change - The impact of global warming on human survival was felt globally, that led to Kyoto Protocol signed on 11th Dec1997 under UNFCCC (United Nation Conference on Climate Change) where in all 84 participating states committed to restrict the emission of human made greenhouse gases. But this could not be taken so seriously due many known and unknown reasons. The second convention held at Paris in 2015 with 195 state participations, took the issue more seriously and it was committed that global temperature rise should be restricted to 2 degree C, and further efforts should be made to 1.5 degree C, from preindustrial level year1860- 1880, by the end of this century. It became a legal binding, and each state were asked to give their Nationally Determined Contributions (NDCs) to achieve the goal.

The 2021 UNFCCC, also known as COP26, held at Glasgow further tightened the screw on all nations to restrict greenhouse gas emission and carbon neutrality (when carbon emission equals carbon sequestration and utilization resulting net zero carbon emission). India committed to achieve carbon neutrality by 2070. Other nations, China and European Unions, have also committed to achieve around the middle of the century and so.

Fossil fuel is the major source of global energy. Around 85% of global energy is sourced from fossil fuel. India taps around 90% of its energy from fossil fuel consisting of coal, oil, and gas. Coal emits maximum Carbon Dioxide (CO2) on combustion, when compared with oil and gas. For producing one million British thermal unit (mmbtu) of energy coal emits 214 to 228 pounds of CO2 on its combustion, depending upon quality of coal, whether it is bituminous, lignite or anthracite, oil 157 to 161 pounds and natural gas 117 pounds.

Correlation of Carbon Emission, Environment and Economy - CO2 emission is directly related with energy production which is essential for industries which in turn essential for progress and prosperity for the nation. The development of a nation is measured by the quantity of energy that it consumes per capita.

There are many mathematical correlations developed that indicates relationship between carbon emission, economic growth and environmental degradation, these are used for predictions by many agencies.

The impact of human activities on the environment (I), developed in 1970, is the product of Population (P), Affluence (A) and Technology (T).

I = P. A. T

This is similar to **Kaya Identity** developed by energy economist Yoichi Kaya in 1993 that correlates the carbon emission with population, GDP and energy consumption and expressed as

$$F = P \cdot \frac{G}{P} \cdot \frac{E}{G} \cdot \frac{F}{E}$$

Where:

- F is global CO2 emissions from human sources
- P is global population
- G is world GDP
- E is global energy consumption[4]

And:

- G/P is the GDP per capita
- E/G is the energy intensity of the GDP
- F/E is the carbon footprint of energy

Environment Kuznets Curve (EKC) is a hypothesized relationship between environmental quality and economic development. This hypothesis was developed by Simon Kuznets in 1950s and 1960s. Various indicators of environmental degradations tend to get worse as modern economic growth occurs until average income reaches a certain point over the course of development. The EKC suggests, in sum, that "the solution to pollution is economic growth". The curve is inverted U – shaped, when plotted as environmental degradation against economic growth. Graphic representation of the curve is shown below in Fig-3.

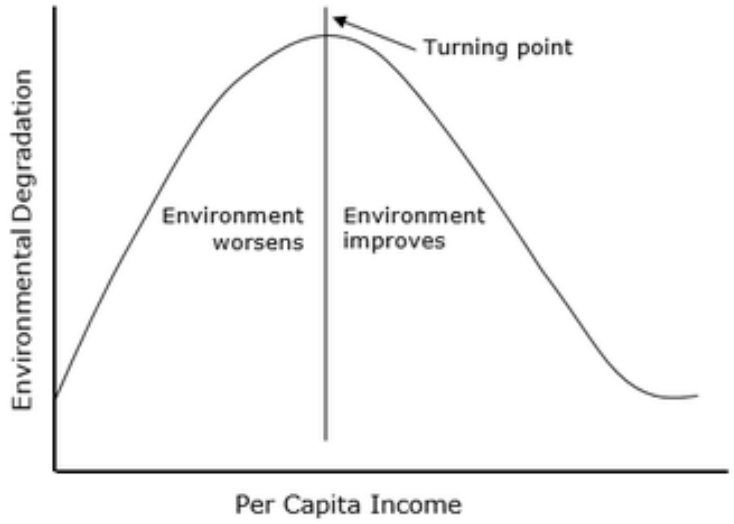

Fig-3. Environmental degradation against economic growth.

Hypothetical environmental Kuznets curve: a translation of the Kuznets curve to the use of natural resources.

Global Carbon Emission - As per the article, issued by ET on Science Climate, in Oct 21, the planet is on the track to reach the global temperature, 3 degree C, that will result in our current coastlines gone, Bangkok under water, massive decline in fish population, more draughts, downpours and heat waves. Bad for humans, bad for ecosystems, bad for the stability of the earth systems that we humans depend on for everything. As estimated, around 12% of the current population living on land could be threatened, resulting in huge migration from coastal area.

Global CO2 emission started rising from preindustrial period 1860-80 onwards and 1950s it was as low as 6 billion tons per annum. By 1990 it almost quadrupled reaching more than 22 billion tons. It continued to grow exponentially and reached to as high as 37 billion tons by 2020. A trend of growth starting from mid of eighteenth century is given below in Fig-4.

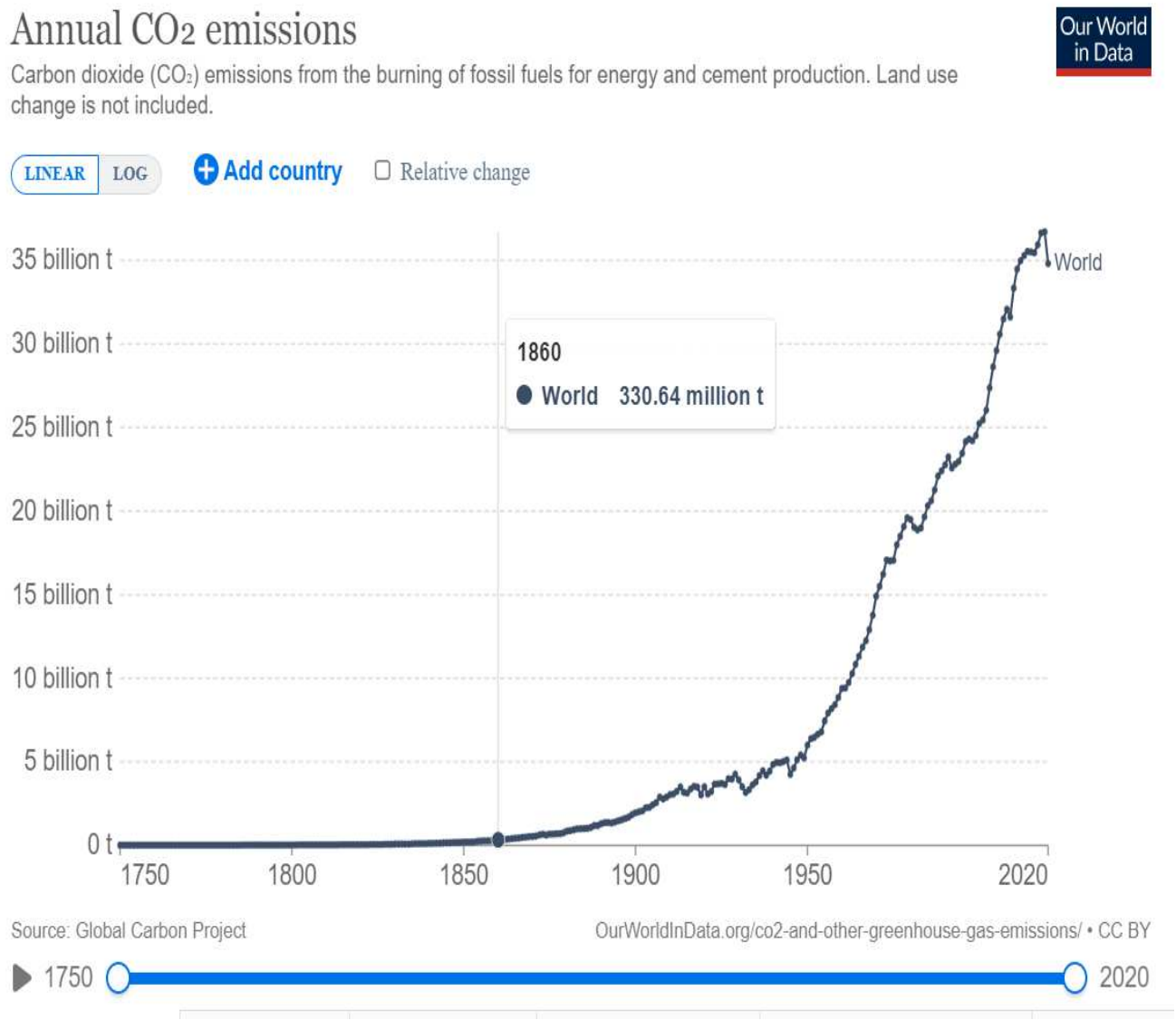

Fig-4. Annual CO_2 emissions

China is the highest CO2 emitter of the world which accounts for more than 30.5% of global emission, followed by US that accounts for 13.5%. India emits 6.9% of global emission. In terms of per capita emission US is the highest which is 15.52 tons per year per capita, followed by Russia11.44 and then China7.38 tons per capita. Per capita emission by India is1.91, much less than global average of 4.5 tos/year/capita.

Emission trend on timeline, by different nations and regions are shown below in Fig-5.

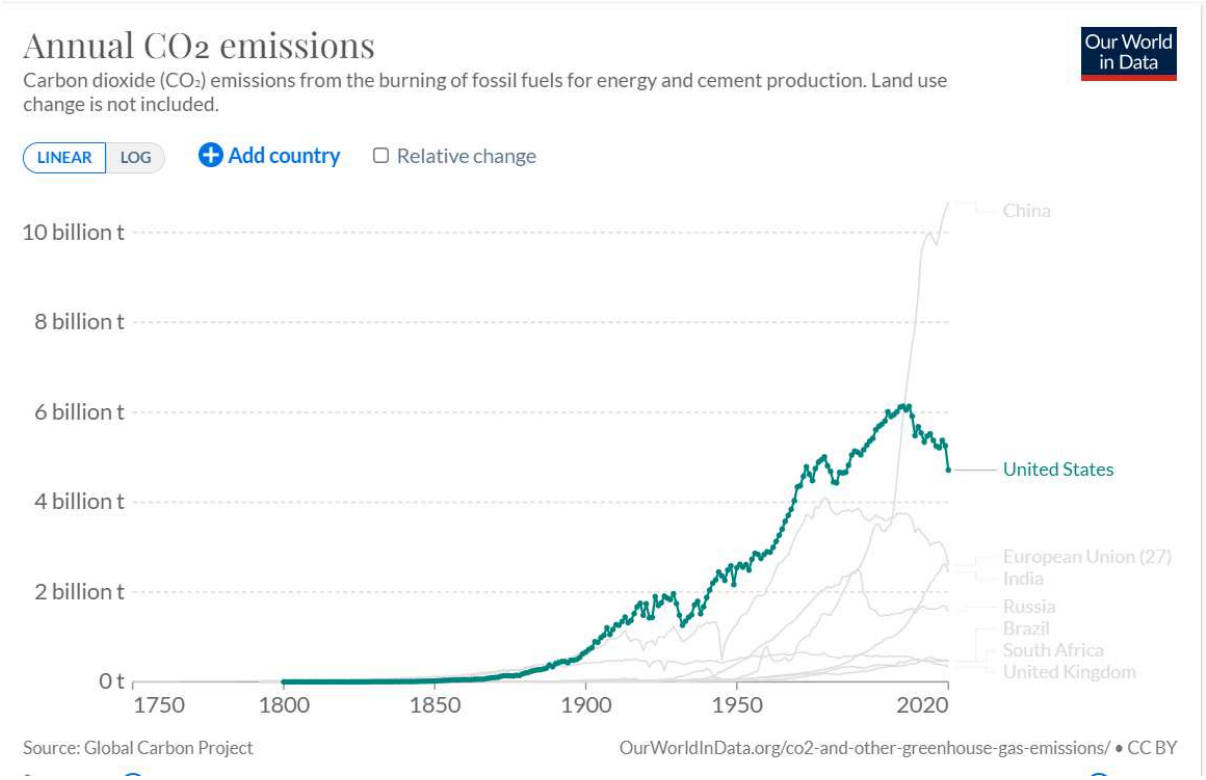

Fig-5. Annual CO_2 emission

Awareness and Actions Taken - In view of the global scenario, predicted at the end of this century, arising due to global warming and its rising trend, there is big threat to the survival of humankind. This has awakened global environmental consciousness. The major source of carbon emission, fossil fuel, particularly coal, that emits highest carbon has been put under restricted use, globally. Replacement of fossil with renewable, hydrogen fuel, fuel cell has been put on fast track to meet the goal of Paris Agreement made in 2015, under UNFCCC to restrict the rise of global temperature below 2 degree C from pre-industrial level. Many technological advancements in fuel technology such as hydrogen fuel cell, water electrolysers to produce hydrogen, green hydrogen, battery for power storage, PEM (Proton Exchange Membrane) technology, CCUS (Carbon Capture, Utilization and Storage), have been taking place.

COP26 (Conference of Paris 26) held at Glasgow made many declarations for climate change and sustainable development. Emphasis given on conservation of forests and other terrestrial ecosystems and accelerating their restoration. It was committed to working collectively to halt and reverse forest loss and land degradation by 2030 while delivering sustainable development and promoting an inclusive rural transformation. Burning of coal, that emits highest carbon was restricted or the process to be made environment friendly with low carbon footprint through carbon capture, utilization, and sequestration.

India, by our Prime Minister himself, has made five declarations in the name of "Panchamrit" for climate change and sustainable development with an objective to achieve the target to restrict the global temperature rise below 2 degree C by the end of century, from pre industrial level (1860-80). These are

1. Net zero carbon emission by year 2070.
2. 50% of nation's energy requirement will be met with renewables by 2030. The present installed capacity from renewables is 38%, being third largest producer of energy from renewables in the world.
3. To reduce total carbon dioxide emission by 1 billion tons per annum, by 2030. The present emission is 2.6 billion tons.
4. Non fossil based energy generation capacity of India to be 500 GW by the end of 2030 from existing 40.9%.
5. The carbon intensity of the economy (per GDP) would be reduced to less than 45% by 2030 from 1995 level. The present reduction is 35%.

Govt of India has made huge investment towards renewable, particularly solar and wind, in participation with private companies like Reliance, Adani and ReNew. Many schemes and mission such as National Hydrogen Mission, Biofuel, Coal Gasification have been initiated by the government with many incentives and financial supports.

In the four months after the launch of the National Hydrogen Mission in Feb,22 three energy giants – Reliance, Adani, and most recently ReNew (in partnership with Larsen and Toubro), have announced entry plans for the green hydrogen market. India's green hydrogen plan (hydrogen is produced with water electrolysis, sourcing electric power from renewable, without carbon emission) aims to cut down the present production cost of around US$5-6 to half at around US$2 per kg by 2029-30. One kg of hydrogen can drive a car 90 to 95 kms on road which is around six times of petrol. On burning hydrogen emits no carbon but only steam.

Reliance, which is a major player in the hydrocarbon, or fossil fuel segment has committed to making green hydrogen available at US$1 per kg by 2030.

India holds the fifth highest reserve of coal sharing 9.5% of global reserve, followed by US, Russia, Australia, and China. It is estimated that at the present rate of production of th coal, India, can last for more than 135 years. But the use of coal is being restricted due to pollution and high carbon emission. Coal alone emits 70% of emission in energy sector with 80% water consumption by energy industries. To reduce the emission from burning, Coal Gasification process is being encouraged that can be used for heating by synthetic gas or the same can be used to many

valuable chemical conversion including hydrogen. Government has prepared a mission document to 100 million tons of coal gasification by 2030 with private participation. Adani has already inked MOU with Chhattisgarh govt to invest 25,000 crores for coal to polygeneration (CTP) plant. Polygeneration plant produces two or more marketable products. Jindal Steel and Power Limited (JSPL) have set up DRI (Directly Reduced Iron) plant at Orrisa through partial oxidation (also called coal gasification) of coal instead of using natural gas.

There are many such schemes being implemented not only in India, but all over the world to reduce the carbon emission with an objective to meet the global warming target of restricting the rise of global average temperature below 2 degree C, by the end of the century

Jharkhand state, spread over 79.7 thousand square kilometre geographical area, covering 29.6% forest, owns about 40% of the total national reserve of minerals. It occupies 1st position in coal reserve, 2nd position in iron ore and 3rd in copper ore reserve. In addition to all these, the state is blessed with many other minerals such as limestone, dolomite, manganese, mica, graphite, coal bed methane and many others. This puts the state in very high position in contributing towards carbon emission reduction. Today more than 80% of coal produced is fired in combustion chamber for power generation.

Exploitation of Coal Bed Methane (CBM), gasification of coal in place of direct firing in furnace, Coal to Chemicals, are the ways through which the coal can be best utilized by reducing the carbon emission, more efficiently. Coal, instead of burning, can be converted to useful products like Hydrogen, Dimethyl Ether (DME), Methanol, Ethanol, Benzene, Phenol and many other valuable products, reducing the carbon emission greatly. Direct reduction of iron ore (DRI) using hydrogen by coal gasification, in place of using coal, in the steel manufacturing plants in the state can be investigated. This methodology has been implemented by JSPL in Talchar, Orissa.

Conclusion

Nature has self-curing ability to any external intervention into the environment, but not beyond certain limit. When the limit exceeds, the ecological balance on the planet is disturbed. Global warming is the outcome to this imbalance. Global warming, arising mainly due to anthropogenic carbon dioxide emission, is threatening to human survival on this planet and if this exponential rise is not restricted, it can lead to many catastrophic conditions such as extreme heatwaves, draught, heavy storms, floods, and many others.

There is no doubt that there is much global awareness about the environmental degradation and consequence of global warming. Also, it is a fact that actions have been taken as well. But it needs much more, to keep a balance between carbon emission and growth. Renewables are replacing fossil fuel, particularly to coal, that emits highest carbon on combustion. Technological advancements have been taking place towards hydrogen economy. Combustion efficiency and low carbon emission technologies, biofuel and many other sources of energy are being investigated that emit low carbon footprint.

Jharkhand that stores 40% of national mineral reserve and produces highest coal in the nation can contribute largely to protecting environment. Exploiting Coal Bed Methane, Coal Gasification at pit mouth and transporting the synthetic gas (a mixture of hydrogen and carbon monoxide) so produced, in place of coal, Coal to Chemicals instead of burning directly in the furnace, are some of the ways and means that can be investigated.

Much more need to be done on much faster track to avoid the global temperature rise more than two degree C with reference to preindustrial level (1860-80), by the end of this century. Hope that consolidated efforts made and being made globally will make it possible to make each day better than yesterday.

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