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Carbon and land use

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Atmosphere of the globe is house of several gases and few of them contributes to global warming when they exceed certain amount are known as greenhouse gases (viz CO_2, CH_4, N_2O, CFC, CO etc.). Mixed greenhouse gases ($WMGHG_S$) are those whose concentration in the entire troposphere is relatively homogenous which might be due to atmospheric mixing and can be attributed to the greater atmospheric life time of these gases, CO_2 is a major $WMGHG_S$. The increase in the concentration of CO_2 in the atmosphere was observed @ 2.0 ppm yr^{-1} from 2000 to 2011 while it accelerates at increasing rate annually @ 2.4 ppm yr^{-1} from 2011 to 2019 however, the current situation revealed to be 409.9 ± 0.4 ppm (NOAA measurements). This is an alarming situation and action must be taken as if this kept continuing then the day is not far to see us human beings living inside of an oven which we once called our mother earth. The surface mixing ratio of CO_2 has been increasing since ages and reached a peak while El Niño events of 1997–1998 and 2015–2016 (Bastos *et al.,* 2013; Betts *et al.,* 2016).

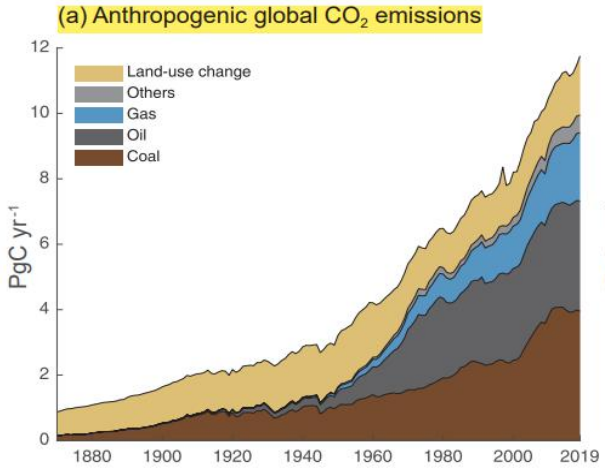
As plants utilize CO_2 for photosynthesis whose growth is restricted at an extent and is characterized as seasonal hence leads to large seasonal cycling of CO_2 during their growth

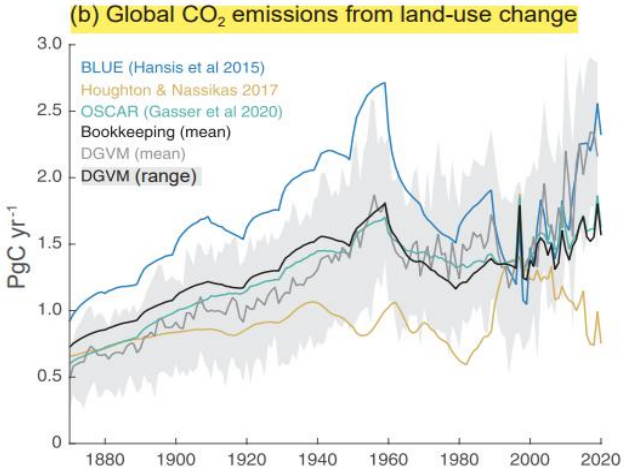
period. It was reported that the seasonal growth pattern the Northern Hemisphere is responsible for seasonal variation in CO_2 concentration, similar trends were observed in the Southern hemisphere also (SRCCL).

Moreover, various scientists have documented the increase in length of thermal growing season (the duration in the year which provides the temperature sufficient enough to support plant growth). Dunn et al., 2020 reported the increase of 2.0 days in the entire Northern Hemisphere over a decade, increase of 1.3 days in North America per decade was reported by Kukal and Irmak in 2018 and similar findings were reported in various parts of the world. NDVI obtained from various land areas is the evidence to the fact that changes in the length of photo synthetically active growing season.

Global greening is the increase in Green leaf mass while global browning is its decrease. Global greening has been found to increase in parts such as China and India but noteworthy is that it is mainly due to agricultural intensification whereas some areas such as Amazon, Central Asia and Congo basin has experienced browning. But the rate of browning has exceeded that of browning therefore the increase in global greening has been slower for last two decades.

There are mainly two sources which causes anthropogenic carbon dioxide emission i.e., fossil fuel burning and soil emission via adopting the changes in land use and management practices (IPCC **year).** Almost economic sectors of the globe viz: electricity, transport, industrial and buildings are dependent on fossil fuels burning and results on the emission of CO_2. Moreover, cement and other agro-chemical, agro-fertilizer industry consume carbonates and emit CO_2. To meet the current demand and feed the nation, the industrialization increases at an increasing rate which implies to the continuous growth in the emission of CO_2 (Peters et al., 2012; Friedlingstein et al., 2020). The past decades implies that fossil fuel burning was responsible for 86% of the total anthropogenic CO_2 emission and has reached to on an average of 9.6 ± 0.5 PgC yr^{-1} which is atpar from all the previous records. The carbon emission in 1990 was increased by 0.9% yr^{-1} to 3.0% in 2000 however, it declined to 1.2% in next decade 2010-19 which is attributed to the reduced use of coal. The shocking storm towards the declining of carbon emission by fossil fuel burning of 7% was recorded in a year span 2019-20 due to COVID-19 pandemic (Forster et al., 2020; Friedlingstein et al., 2020; Le Quéré et al., 2020; Z. Liu et al., 2020).





Second source of anthropogenic CO_2 emission is the changes in the land use and management & forest cover. Forests are developed in response to the environmental changes in any area but these

areas are being cleared for agricultural and other human uses (Pongratz et al., 2014). The carbon being sequestered by the forest cover was having the greater mean residence time but due to the replacement of these areas with agriculture areas have reduced the residence time of the carbon in soil, they lack woody material and are considerably poor additional sink of carbon in soil (Gitz and Ciais, 2003). Gross emissions are on average two to three times larger than the net flux from LULUCF (land use land use change and forestry), increasing from an average of 3.5 ± 1.2 PgC yr–1 for the decade of the 1960s to an average of 4.4 ± 1.6 PgC yr^{-1} during 2010–2019 (Friedlingstein et al., 2020).

Carbon is an non-separable and irreplaceable element for the plant growth and constitutes about 45% of the plants body. Plants sequester this carbon from the atmosphere through photosynthesis and act as a sink for carbon. Soil carbon sequestration leads to the long-term entrapment of atmospheric carbon into the soil, plant biomass and other organic sources results to increase in the productivity of soil and gain sustainability of the system in the global carbon cycle. There are various land use patterns viz Agricultural, Horticultural and Agroforestry which adds sustainentail amount of carbon into its active and passive pools depending upon the land use. The Active pool of soil organic carbon is one which has lower mean residence time in soil and can be utilized by plants and soil microorganisms while the passive pool is one which has the higher mean residence time in soil in comparison to active pool of carbon and is not readily utilized by plants and soil microbes. The active pool fractions includes very labile, labile, microbial biomass carbon, potassium permanganate oxidizable organic carbon while passive pools are less labile and non-labile carbon. Enrichment of both the pools of carbon leads to the enhancement of physic-chemical properties of soil as well as carbon sequestration which in turn leads to the reduction in lethal concentration of carbon dioxide in atmosphere.

Green vegetation potentially sequesters the global carbon but is not enough to maintain the sustainability of particular land use system. In order to maintain the sustainability of a system various scientists have made studies by evaluating the various pools of carbon, sequestration potential and sequestration rates of the lands which were under practice of Agriculture, Horticulture and forest based. However, the globe is in opined to promote the agricultural land use so as to feed the nation. But it would be the hindered to sustain the global carbon sequestration under following reason:

1. The agricultural land use is temporary and leaves the soil naked up till the next cropping season.
2. Mechanical disturbance in this system leads to physical degradation of soil as well as higher mineralization rate of added organic material.
3. Use of heavy dose of fertilizers, pesticides and other chemical leads to chemical and biological degradation of soil.
4. The amount of carbon added in soil is lesser due to over harvest of produce (out flux does not match the influx).
5. The type of carbon added in soil by crops is having vary low mean residence time in soil due to lack of woody nature of the material and lesser biomass.

Therefore the temporary agricultural practices should be replaced by such practices which are settled and act as potential carbon sinks.

Many studies have proved that the tree based land use has led to the development of soil carbon content which states that tree based land use is more potent in sequestering carbon from atmosphere into the soil due to greater canopy cover, unceasing accumulation of organic matter through litter fall, root deposition and

encouraging microbial milieu. Chandran et al. in 2009 stated that there was a 23% increment in carbon status of soil within a time period of 20 years by practicing horticulture and agroforestry based land use as compared to agricultural land use.

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