

CARBON SEQUESTRATION: ASSESSMENT AND APPLICATION-A REVIEW¹ Jaspal Singh*, ²Puneet Khare, ³Shivshanker Yadav, ¹ Neha Gupta and ¹ Anamika Agarwal¹Department of Environmental Science, Bareilly College Bareilly, U.P. 243005, INDIA.²Central Instrumentation Facility, CSIR-Indian Institute of Toxicology Research, Lucknow U.P. INDIA.³Department of Zoology, Lucknow University, Lucknow, U.P. INDIA.***Corresponding Author: Dr. Jaspal Singh**

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ABSTRACT

Human activities are harming the Earth's global Carbon cycle (CC). Carbon pollution or the increase in the concentration of Carbon dioxide in air due to the anthropogenic sources is proving hazardous to our environment and causing all sorts of disasters from warming the earth and raising the sea level. In this Context, one of the feasible solution is the capturing of Carbon dioxide and depositing it in a reservoir or Carbon Sequestration. Plants are the natural sinks of all types of pollution and so as oceans. In order to combat global warming, it is essential to limit the discharge of CO₂ in the atmosphere. **OVERVIEW:** Carbon is the macronutrient for all the life processes to sustain life. It shows different chemical properties and occurs in various allotropic forms. It is the maximum content in the biomass of living organisms. Although, CO₂ maintains the heat budget of our planet but because of anthropogenic activities the effect of CO₂ on our environment has increased manifolds. Our earth receives energy in the form of short wavelength including Visible part of the spectrum of which most of the part is reflected back. Our earth reflects in the form of Infra red radiations which in turn are absorbed by some of the gases called as green house gases (Carbon Dioxide, Methane, Nitrogen Oxides etc). These green house gases are increasing in concentration day by day due to various anthropogenic activities and thus heating the earth causing Global Warming. Over the past 150 years the amount of carbon gas increased by 30%. One of the effective measures to reduce carbon dioxide emissions is to deposit it in a sink. No doubt, Carbon Capturing and Storage has become the mode of choice to meet out the excessive CO₂ and thus Global Warming too.

The present review article is concentrated on the CO₂ status in the atmosphere, causes for its excessiveness and finally revealed that the CCS (CO₂ capturing and storage) is most prominent mode to decline the surplus CO₂ level in the earth's atmosphere. The sequestration of carbon is the most diverse field to work in today as the maximum threat to us is because of Global Warming and Climate Change.

STATUS OF CARBON IN ATMOSPHERE

The concentration of carbon in living matter is 18% which is about 100 times more than the concentration in earth that is 0.19%. Therefore living beings have to extract carbon from their biotic environment. Carbon exists in the environment in three forms carbon dioxide, carbonic acid, deposits of fossil fuels and dead organic matter such as humus. Carbon enters the food chain through autotrophs by photosynthesis and to a small extent via chemo autotrophs.

Carbon is returned to the atmosphere by respiration and decay of matter. The concentration of carbon dioxide is increasing day by day. The increase in the CO₂ concentration has increased due to Industrial revolution. Samples of the air trapped in glaciers about 300 years

back has shown no increment in CO₂ concentration so the increasing concentration is due to human activities.

The increased CO₂ concentration has some serious effects

- Increased growth of forests and growth of woody shrubs in Tundra region which was barren 50 years ago.
- Increase in the concentration of photoautotrophic planktons in oceans.
- Increase in the temperature of earth by 0.7 degree Celsius which can be 1.1-6.4 degree Celsius in the end of this century on doubling the CO₂ concentration.
- Many angiosperms are flowering earlier in temperate climates.
- Many glaciers are receding and increasing sea level. Black carbon soot is melting Himalayan glaciers.
- Many organisms like birds and butterflies are heading towards north for breeding earlier in springs.

SOURCES OF CARBON IN ATMOSPHERE

India ranks fourth in carbon dioxide emissions in world with total emissions (excluding land use) 1,007,980 metric tons which is about 4.4% of total world emissions.

The chief sources are

- Fossil fuel burning
- Cement manufacture
- Deforestation
- Land use change
- Burning of wood fuel

It is obvious that energy-intensive activities are of the highest relevance and that fossil-fuel combustion accounts for 90% of the total CO₂ emissions (excluding deforestation and other land uses). Power generation remains the most important sector related to fossil-fuel consumption; therefore, the choice of fossil fuel by the power sector is of the utmost importance. Besides, this CO₂ emissions from cement clinker production (the largest source of non-combustion-related CO₂ emissions, contributing 4.5% to the global total).

CARBON SEQUESTRATION: AN APPROACH

Carbon capture and storage (CCS) is a method for long-term isolation of the CO₂ generated in combustion facilities that otherwise would have been emitted into the atmosphere. In other words it may be defined as the long term storage of carbon dioxide or other forms to mitigate global warming. The method involves capturing and storing CO₂ in suitable geological formations.

As per Jos G.J. Olivier *et al* (2013) CCS process having three stages

(1) First Step is capturing of CO₂

Involves separation of CO₂ from the other gases produced when fossil fuels or biofuels are combusted to generate electricity, or when CO₂ is produced in other industrial processes.

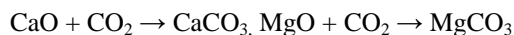
(2) Transport

Once separated, the CO₂ is compressed and transported to a suitable Geological storage site.

(3) Finally, storage

CO₂ is injected into deep underground rock formations, such as deep saline aquifers or depleted hydrocarbon reservoirs, often at depths of 1km or more. Captured CO₂ is compressed under high pressure until it reaches supercritical state, then stored in deep geological structures. The capturing technologies can be classified in 3 large groups: Post-Combustion, Pre-Combustion and Oxy fuel (IPCC, 2005).

All crops absorb carbon dioxide during growth and release it after harvest. Carbon is in the form of CO₂ and that can be removed from atmosphere by the chemical process and stored in carbonate forms. This process is called mineral carbon sequestration. This process involves the reaction of carbon dioxide with abundantly available metal oxides either magnesium or calcium.



Cement manufacture also releases large amount of carbon dioxide. Carbon dioxide sequestration can also involve the injecting of CO₂ into deep sea formations where it reacts with basalt forming Ca²⁺ and Mg²⁺ stable carbonate minerals.

INNOVATIONS TO SEQUESTER CARBON

Urban planning with high tolerant species

The rate of carbon sequestering depends on growth parameters of the plants. Density of wood of plants plays a major role. Since there is less research on the carbon sequestering capabilities of plants. Some trees can store large amount of carbon in their roots and branches. This can be easily calculated by various online tools for instance *Greg. Mc. Pherson's Tree Carbon Calculator*. This simple CO₂ calculator needs only some information mainly climate region in which you live, the species of tree, and either its size or its age and then estimates how much carbon dioxide has been stored in the tree over the past year, and its entire lifetime (Greg McPherson).

This makes easy quantifying of carbon benefit of a tree. Even the usage of grasses and weeds as a temporary cover is quite effective. By comparing and diagnosing all the parameters an effective green belt modal can be designed which covers all the parameters like selecting and plantation of those species which have high carbon sequestering potential in accordance with the land based carbon absorbing zones. This can add to aesthetic beauty of a green belt in an area. The advantage to this project is the Zero tillage farming/ plantation.

REDUCING EMISSIONS BY DEFORESTATION AND DEGRADATION (REDD)

Deforestation is the permanent removal of forests and land use while Forest degradation can be defined as the negative externalities in the forests that limits or checks its productivity. In recent years forest degradation and deforestation accounts for 25% of green house emissions larger than the transportation sector.

In 1997 global climate conference, The Kyoto Protocol there were policies related to REDD but due to complexity in measurements and proper monitoring for the diverse ecosystem it was excluded. REDD activities are undertaken by nationals, local government, NGOs and private and public sectors. It also includes establishment of national parks, protected areas and reduced impact logging.

OCEANIC CARBON SEQUESTRATION

As carbon sequestration is long term storage of carbon dioxide or other forms to mitigate global warming in this connection one of the finest places to sequester CO₂ is in oceans. Oceans capture about one third of carbon emitted which is about two billion metric tons per annum. It is the surprising fact that the amount of carbon which doubles the load in the atmosphere increases just about

2% of the concentration of sea water when emitted in oceans. As CO₂ is denser than sea water it can be stored in the bottom of the sea water as liquids or icy hydrates. This had resulted in the decrease of pH of oceanic water to about 0.1% at its surface with overall no change in the pH in deep oceans. It is presently very unpredictable that how species and ecosystem would adapt to elevated CO₂ level in oceans. The marine biological impact assessment and the monitoring technology are quite essential for CO₂ ocean sequestration. It is very interesting to work in this research field because it can prove very efficient technology in coming times and will prove very important in recovering Earth from Global warming and Climate change to an extent.

RECOMMENDATIONS AND CONCLUSION

The largest CO₂ emitting country by far was China, which share of 29% in 2012 was much larger than the second-largest, the United States, with 16% and the European Union with 11%. India is the fourth largest CO₂ emitting country, following the European Union, and well ahead of the Russian Federation, which is the fifth largest emitting country (Jos G.J. Olivier *et al.*, 2013).

India is a developing country and its population is increasing at an exponential rate. Each individual has a certain carbon footprint or the amount of carbon released per person per year which is about 1.7 tons. On the other hand due to industrialization carbon footprint of India is increasing day by day. India ranks 145 in carbon emissions globally. The most suitable way to control this is carbon sequestration. By combination of carbon sequestration with Green Belt Designing, can lay its foundation in Indian subcontinent as an effective approach. Plants act as a carbon sink and alone can dispose much amount of carbon. India lacks an efficient Green Belt designing throughout the country. Plants which are used here are of very little importance with respect to environmental protection. Modification in plantation techniques can be a recognized method of carbon sequestration and as we know soil also acts as an effective carbon sink (estimated to contain approximately 1500 gig tons of organic carbon globally) offsetting as much as 25% of Carbon dioxide emissions annually.

India depends on coal for generation of electricity which is the prime source of carbon pollution. The increasing warming and the change in the rainfall pattern is drastically effecting the natural resources, mountains and coasts where population density is quite high. Ocean carbon sequestration is an innovative technology in India because it is surrounded by the ocean from three sides and has a long coastline. The approximate fraction of carbon emission with respect to the total emissions can be treated and dumped into the deep oceans. Even carbon can be stored in the ocean bed. The major carbon pollution sources in India are Industries, Fossil fuel combustion, Municipal solid waste combustion,

Petrochemical production, Petroleum systems etc. Ocean Carbon dioxide Sequestration is an innovative technology and would give surprising results for R& D if used progressively and effectively and prove beneficial to the entire country and its citizens.

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