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ORGANIC CARBON SEQUESTRATION EXAMINATION THROUGH SOIL ADVANCEMENT

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Abstract

Carbon sequestration in terrestrial ecosystems is, according to the Kyoto Protocol, a low-cost alternative to reducing increasing CO2 concentrations in the atmosphere. It is understood that the planet's trees and their soils have a high potential for atmospheric carbon sequestration. For the last two decades, scientists have been increasingly involved in terrestrial soil carbon storage processes. The goal of this study was to summarize the significant chronological progress of soil organic carbon sequestration (SOC) research and also to underpin the issues that have yet to be addressed globally by this research.The investigator recently published on the temperature sensitivity of organic carbon and its stabilization function in various types of soil. The researchers were interested in the contribution of microbial derived carbon to the recalcitrant SOC pool and the sequestration period of microbial derived carbon in different ecosystem types. Investment in SOC sequestration is certainly insufficient to fix the fate of sequestered carbon in different soil types and their stabilization mechanisms. India is a nation that spreads across regions with diverse types of fragile ecosystems and vulnerability to global climate change, from temperate to dry desert areas.

Keywords: *Carbon Sequestration, Carbon Stabilization, Recalcitrant Pool AndSoil Organic Carbon Pools Labile..*

I. INTRODUCTION

The rising global surface temperature level is a major concern for developed and developing countries worldwide, as its effect has been felt primarily on changes in the monsoon scenario, drought, flooding and sea-level rise. The amount of CO2 present in the atmosphere plays a crucial role in maintaining global surface temperatures; it has historically fluctuated between about 180 ppm and 280 ppm during interglacial periods. Due to fossil fuel burning, cement manufacturing, deforestation and agricultural development, the pre-industrial level has risen from around 280 ppm to 391 ppm now[1].The amount of CO2 rises at a rate of 0.4 percent or 1.5 ppm year-1. Likewise, CH4 grew from 0.80 to 1.74 ppm and increased at a rate of 0.75% or 0.015 ppm year-1 while N2O grew from 288 to 311 ppb and rose at a rate of 0.25% or 0.8 ppb year-1.Earth's surface temperature has risen by 0.74 C since 1850 and is predicted to rise by another 1.1 to 6.4 C by the end of the century[2].

There is a clear awareness of the need for options to be identified to reduce CO2 concentrations in the atmosphere. "The first international treaty to address the issue of climate change by working to avoid anthropogenic interference was the United Nations Framework Convention on Climate Change (UNFCCC), adopted in Rio de Janeiro in 1992, with the main objective of "stabilizing greenhouse gases in the atmosphere at a point that will prevent harmful anthropogenic interference with the climate system[3].The Kyoto Protocol, signed by many countries but not by the big CO2 emitters, allows developed nations to reduce their net emissions by an agreed sum with respect to the 1990 level and considers a broad variety of options for reducing the risks of global warming[4].

In recent deliberations on climate change / global warming in Copenhagen (2010) and Durban (2011), attempts by developed and developing countries have become almost futile in adapting the noteworthy regulations on climate change. India is also one of the nations which is more vulnerable than its developed counterparts to the consequences of climate change. The Kyoto Protocol (KP) states that to minimize greenhouse gas emissions, carbon sequestration in ground sinks should be used. The current economic growth rate and India's contribution to environmental protection require forests and other critical habitats to be conserved.Nevertheless, there is still a lack of research on sequestration of SOCs in vulnerable habitats like India's forests, croplands, wetlands, and grass / pasturelands. Through this study, an attempt was made to summarize the main historical progress of SOC sequestration research through terrestrial ecosystems and also to underpin the issues that have yet to be based on this research on a global and regional level[5].

II. METHODOLOGY

Carbon Sequestration:

Carbon sequestration requires the capture and absorption of atmospheric CO2 by abiotic (engineered) and biotic methods into stable ocean lakes, geologic basalts, vegetation and soil.

- **Abiotic Strategies:**

This includes the processing, storage, compression, transport and injection of CO2 deep into geological basalts and oceans from industrial flow gases and effluents. Abiotic carbon sequestration techniques are still in their infancy, so it takes a lot of time to introduce abiotic carbon sequestration methods, chemicals and equipment, as these strategies are primarily based on current engineering techniques [6].

Consequences of Abiotic Carbon Sequestration:

The oceans absorb CO2 from the atmosphere and by making it more acidic, this creates chemical changes. Over the past 200 years, about half of the CO2 created by burning fossil

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fuel and cement production has been absorbed by the oceans. At the start of the industrial revolution about 200 years ago, the pH of the ocean surface waters has indeed dropped by about 0.1 units from around 8.15 to 8.04.If global CO_2 emissions from human actions continue to grow in the current trend, then by the year 2100 the average ocean pH will fall by 0.5 units (equivalent to a triple increase in hydrogen ion concentration). Ocean acidification, as the trend is known, would have significant adverse effects on corals and other marine life over time, with potential adverse effects on fisheries, tourism and related economies.Nevertheless, many of the deep sea's biological, chemical, and geological components are little understood, and thus, the results of carbon dioxide injection into the ocean are largely unknown. However, if the CO_2 spills from a storage site, there could be risks for humans, wildlife, and ground water[7].

- **Biotic Strategies:**

Unlike oceanic and geological carbon storage methods, terrestrial carbon sequestration in biotic strategies is focused on the natural photosynthesis cycle and the conversion of fixed atmospheric CO_2 into vegetative biomass and reservoirs of SOM. SOM is a complex mixture of plants, animals, and microbial materials pooled with a variety of decomposition products at varying turnover rates in various stages of decay. SOM is globally a big carbon storehouse.SOM accumulation, of which about 58% is biomass, occurs during the growth of the ecosystem as a result of interactions between biota (e.g., autotrophs and heterotrophs) and environmental controls (e.g., temperature, humidity). For various types of natural habitats, the rate of SOM accumulation depends on the litter inputs (quantity and quality) and the rate of decomposition.

Clearly, SOM's rate and accumulation are closely linked to the quality of the recent / past vegetation, physical and biological conditions in the soil, and the past history of SOM inputs and land management activities. Accumulation of the SOM thus varies from natural habitats to man-made habitats. The rate of accumulation of SOCs from the polar desert (0.2 g C m2 year-1) to the temperate forest (12 g C m2 year-1) worldwide has been recorded. Accumulation of SOCs is around 20.31 Tg year-1 in Indian forest soils.However, there has been considerable amount of work over the last two decades, based on simulation models, to measure the accumulation rate / turnover of SOM in different types of ecosystems (see detailed section on SOM model). The naturally occurring sources of organic carbon (OC) come from plant and animal decomposition. Therefore, anthropogenic additions such as pesticides and industrial waste also form part of OC in soils. A large range of OC types are found in soil, ranging from freshly formed litter like leaves, twigs, and branches to heavily decomposed types like humus.The main parent materials for SOM formation are the plant litter and microbial biomass. As plants grow, CO_2 is absorbed through photosynthesis and a portion of this carbon is incorporated into their body structure. Therefore, carbon sequestration by rising perennial vegetation has proven to be a cost-effective alternative to mitigate global climate change[8].

Therefore, biological carbon management in addressing climate change has basically two components: I reducing biological systems emissions, and (ii) increasing their carbon storage.

This can be accomplished in three ways: protecting existing stores and reducing the current high rate of loss; replenishing historically depleted stores through restoring habitats and soil; and potentially generating new stores through promoting greater carbon storage in areas that currently have none, through afforestation.At the same time, sequestration of carbon (by can forests) can be acceptable from an ecological, political, and socio-economic perspective. The environmental viewpoint involves eliminating CO2 from the atmosphere, enhancing the quality of the soil and increasing biodiversity. Socio-economic gains can be expressed from future carbon trading schemes by improved yields and monetary profits. Carbon sequestration programs could also boost local engagement and awareness of sustainable forest management practices.

Chronological Progress of SOC Research across the World:
Table 1 demonstrates the major development and progression in SOC science. The big flaw in SOC research worldwide is that most of the studies focused only on estimating the carbon stock and/or the mechanism involved in processing organic carbon in various ecosystems. This is due to some mistake and/or lack of understanding of the SOC stock estimation in different ecosystems.

- **SOC Stocks:**

The majority of researchers around the world showed interest in estimating the size / stock of the global SOC in the early seventies to the nineties. Two separate methods were pursued to estimate global stock of SOCs. They are (a) estimates of soil taxonomy, and (b) estimates based on ecosystems. They tabled the SOC stocks in the first approach (taxonomic approach) based on evaluating the area / extent and average carbon content in each of the world's major taxonomic soil groups[9].

In global carbon tabulation, two main soil classification / mapping systems were used, i.e. the U.S. Department of Agricultural Soil Taxonomy (USDA) and the Food and Agriculture Organizations (FAO) world soil map. The SOC stocks (1566 Pg C) of the various soil orders worldwide were determined. SOC stock was low in vertisols, and high in histosols, among the various soil orders. SOC stock was calculated in an ecosystem-based approach based on generalized ecological life zones which are distributed in relation to different combinations of mean annual precipitation and mean annual temperature. This method calculated the global concentration of soil to be around 2532.3 Pg carbon[10].

III. CONCLUSION

Understanding the SOC pools and the processes / mechanisms involved in turning sequestered carbon into a labile / stabilized pool in various soil types under various vegetation cover is quite a challenge. As there is no specific or uniform fractionation technique to distinguish the labile and recalcitrant carbon pool in different types of soils under different vegetation covers, it is very contentious to understand the sensitivity of labile and/or recalcitrant carbon pools in soils to different climatic factors.. In addition to arid and

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semi-arid areas, the rising rate of inorganic carbon in Indian agricultural soils requires special attention from Indian researchers.The future research agenda for carbon sequestration in soil or other habitats will combine several different disciplines and have similar objectives in all different ecosystems, such as calculating the scale, dynamics and turnover of labile and recalcitrant carbon reservoirs (sequestered by forests, agricultural lands in different climatic zones and plantations) than simply estimating the carbon Promoting work on SOC sequestration services in India's degraded lands will help the government and other stakeholders in improving the trade in biodiversity, food safety and carbon credits.

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