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Regulating Effects of Climate, and Net Primary Productivity Depends on Soil Organic Carbon Sequestration

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Abstract

According to the Kyoto Protocol, sequestration of carbon in terrestrial habitats is a low cost alternative for reducing the rising concentrations of CO2 in the atmosphere. It was known that the trees of the planet and their soils have a high capacity for sequestration of the atmospheric carbon. Scientists have been growing interest in terrestrial soil carbon storage processes for the last two decades. This study sought to summarize the significant chronological progress of research on sequestration of soil organic carbon (SOC) and also to underpin the issues that have yet to be based on this research at global level. Work on SOC sequestration started in the early seventies where most studies estimated the size / stock of the global SOC. Many of the researchers started to concentrate in the early 1980s on the factors involved in preserving organic carbon in various habitats. Subsequently, the researchers started to focus on various types of SOC pools in different types of habitats, their scale, turnover and chemical characterization. The researcher recently reported on the temperature sensitivity of organic carbon in different forms of soil and its stabilization mechanism. Researchers have been interested in the contribution of microbial derived carbon in recalcitrant SOC pool and in their sequestration cycle in different types of ecosystems. The investment in SOC sequestration work into the fate of sequestered carbon in various soil types and their stabilization mechanisms is undoubtedly inadequate. India is the nation that stretches through regions from temperate to dry desert zones with different forms of vulnerable habitats and susceptibility to global climate change.

Key words: Carbon sequestration, Carbon stabilization, recalcitrant pool and Soil organic carbon pools Labile

Introduction

The rising level of global surface temperature is a major concern for developed and developing countries around the world as its effect has been felt mainly on changes in the monsoon scenario, drought, flooding and increase in sea level. The volume of CO2 present in the atmosphere plays a crucial role in sustaining global surface temperatures; and during interglacial cycles it has traditionally fluctuated between around 180 ppm and 280 ppm.It has risen from the pre-industrial level of about 280 ppm to 391 ppm now due to burning of fossil fuels, cement production, deforestation and agricultural growth.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[1].

There is strong understanding of the need to define options for reducing atmospheric CO2 concentrations. The United Nations Framework Convention on Climate Change (UNFCCC), adopted in Rio de Janeiro in 1992, with the main goal of "stabilizing greenhouse gasses in the atmosphere at a point that will avoid harmful anthropogenic interference with the climate system',' was the first international treaty to tackle the climate change issue by working to avoid anthropogenic interference.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[2].

The efforts among developed and developing countries in recent deliberations on climate change/global warming in Copenhagen (2010) and Durban (2011) have become almost futile in adapting the noteworthy climate change regulations.India is also one of the nations which is more vulnerable to climate change effects than its developed counterparts. The Kyoto Protocol (KP) states that carbon sequestration in earth sinks should be used to reduce greenhouse gas emissions.

Current economic growth rate and India's dedication to environmental conservation necessitates the conservation of forests and other significant ecosystems. 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[3].

This analysis outlined the following major SOC research areas: I estimate of carbon stocks in different ecosystems (ii) factors influencing SOC storage (iii) soil organic matter (SOM) models (iv) differentiation of distinct SOC pools (v) understanding of SOC temperature sensitivity in different ecosystems (vii) chemical characterization of SOC (viii) carbon isotope calculation.

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 requires collecting, storing, compressing, transporting and injecting CO2 from industrial flue gases and effluents deep into geological basalts and the oceans. Abiotic carbon sequestration strategies are still in their infancy, so implementing abiotic carbon sequestration strategies requires a lot of resources, chemicals so equipment, as these strategies are largely focused on modern engineering techniques[4].

Consequences of Abiotic Carbon Sequestration:

The oceans absorb CO_2 from the atmosphere and by making it more acidic, this creates chemical changes. Over the past 200 years, about half of the CO_2 created by burning fossil 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[5].

- **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[6].

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[7].

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[8].

Chronological Progress of SOC Research across the World:

It has been 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[9].

- **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[10].

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[11].

- **SOC Sequestration In Agricultural Soils:**

Higher priority is the sequestration of carbon in agricultural and degraded soils to restore the ecosystem and combat global climate change. The total agricultural land area on Earth is estimated at about 1.6 billion hectares according to the FAO. That is 12% of the earth's total land (13.2 billion hectares). Since 196 the total agricultural land area has increased by 159 million hectares. Globally, agricultural fields have sequestered 157, 210 and 248 Gigatons of carbon in one, two and a third meter respectively. Farming activities and land-use transition contribute about one-third of total greenhouse gas (GHG) emissions and are the primary sources of methane and nitrous oxide.The amount of carbon efflux from the soil can be restored to the soil by proper land management practices and agroforestry systems that are already included in the climate change framework convention. CO2 loss from agricultural soil will provide a reference point for the potential for carbon sequestration.Numerous studies have shown that soil carbon can increase in cultivated land by implementing conservation practices such as no tillage, no summer fallows and increased residue inputs. Recommended management practices (RMPs) such as tillage conservation, agroforestry, manure use, bio solids, grazing management, and forest management can increase the carbon retention rate in the soil[12].

It is suggested that the agricultural management practices advocated in India over the last 25 years through the national agricultural research program did not cause any decline in SOCs in the country's main crop-growing areas. By combining organic amendments with inorganic fertilizer, the soil quality and productivity of IGP can be enhanced. Long-term use of organic modifications by farm yard manure (FYM) in India's rice fields could increase SOC by 10.7%.

Factors Affecting the Storage of SOC:

The following factors have a significant impact on the storage of carbon in different ecosystem are:

- **Climate, Altitude and Topography:**

Climate has long been thought to affect carbon accumulation in soil. Hot temperatures and poor aeration in wet soils can prevent decomposition, resulting in higher soil carbon stocks in hot and moist biomes and low levels of hot and dry biomes. Temperature and humidity are two critical environmental factors that influence the storage of soil carbon. Overall, SOC increases with higher precipitation, lower temperature, and lower evapotranspiration / precipitation ratio.By general, warm temperate and dry tropical forests had the lowest soil carbon content, while wet boreal and tropical forests had the highest soil carbon levels. The storage relationship between organic matter production in different types of tropical forests and climate is very critical for a deeper understanding of the changes in the global soil carbon stream.The carbon distribution between the plants and the soil varies by latitude. An earlier study stated that a significant part of the carbon reservoirs of vegetation (25 per cent) and soil

(59 per cent) are located in the high latitude forest. Low latitude tropical forests are highly heterogeneous and comprise 59 percent of global forest vegetation and 27 percent of global forest carbon, respectively.In addition to that altitude had a significant effect on species richness which decreases to a latitude increase of even 100 m. The characteristic decrease in vegetation with increasing altitude results in less litter accumulation and low organic carbon production in soils[13].

Very few studies have reported the topographical effects globally Carbon Storage Aspects. Topographic aspects also induce local variations in temperature and precipitation, in addition to chemical and precipitation the principal regulators are the physical structure of the substrate of the degree of decomposition of SOM. Thus the topographic aspects are affecting SOC storage.It was observed that the development and persistence of mollisols in the hills of humid tropical parts of India has been extensively studied. We are found only on the zeolitic Deccan basalt parent material that provided better storage of water for preservation of organic matter in the soil in the adverse environment. The creation and formation of different types of soil (soil) orders) have a major impact on SOC availability in a particular case zone[14].

- **Land Cover or Vegetation Cover:**

The type of vegetation that covers the surface of the earth is referred to as ground cover. Globally, several SOC dynamics studies have concluded that the quantity and relative distribution of SOC is mainly correlated with vegetation cover rather than temperature. Dominant plant life forms or population type changes (e.g. trees, shrubs, grasses, and herbs) affect soil carbon content, as plant life forms vary in litter chemistry, detrital input patterns, and rooting depth.A few studies have also documented that forms of plant life typically differ in the depth and distribution of their root systems which affect soil carbon quantity and distribution. Plant species have the ability to influence soil carbon pool and its dynamics by influencing carbon losses, including decomposition of SOM, through variability in carbon input (that is, net primary production). Among tree species, organic horizon pool sizes (O-horizon) are largely determined by the difference between inputs via litter fall and outputs via litter decomposition and should therefore display marked differences between species varying in those attributes[12].

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- **Soil Texture:**

Soil structures consist of two different fractions of particles; (1) coarse fractions of earth ([2 mm in size) such as dirt, cobbles, rocks and other pieces of soil (2) fine fractions of earth such as sand (0.05–2 mm), silt (0.002–0.05 mm) and clay (0.002 mm). Numerous studies have indicated that organic carbon sequestration in soil depends on texture and is strongly associated with the fine particle proportion. A lot of studies identified a soil's protective capacity as the maximum soil carbon can be correlated with the fractions of clay and fine silt.The production of agricultural products has natural environment modified and the soil disturbed environment, which results in a significant decline in soil carbon; the most carbon emissions occur in the first few years. The depletion of SOCs is accentuated when organic inputs carbon in cultivated systems are lower, and losses due to mineralization and erosion are higher than in natural systems. In tropics, the rate of loss of SOCs due to conversion from natural to agricultural ecosystems is more drastic than in temperate soils[16].

There is enough evidence that the majority of SOCs have declined rapidly and significantly as a result of land use change particularly when natural ecosystems are converted into agricultural onesInstallations. Globally, land use is evolving and soil rising the loss of 136 Pg of soil C to the atmosphere after 1750 is estimated. Globally agricultural production reduces the initial soil carbon content by 30 percent.SOC losses arise in another report as around 50 percent in surface soil up to 20 cm deep after 30 to 50 years of cultivation. Soil carbon loss average was around 40 percent to a depth of 30 cm in the plough layer. Lastly, management behavior will affect the soil quality and productivity are influenced by the labile fraction of the SOC stock. Therefore, implementation has been suggested that SOC storage program requires governments to mandate till farming or provide financial assistance farmer rewards. Business standards embraced just like stubble retention and reduced tillage coal can potentially increase in agricultural soils[17].

- **Effects of Land Use Change on SOC:**

Agricultural growth has altered the natural ecosystems and disrupted the soil climate, leading to a substantial reduction in soil carbon, with most carbon loss occurring in many years. SOC loss is accentuated because organic carbon inputs are lower in agricultural systems, and losses due to mineralization and erosion are higher than in natural systems.

- **Salinity, Sodicity and Soil Erosion:**

Increasing soil salinity and sodium is a big global issue of soil depletion in arid or semi-arid regions and is also predicted to rise in the near future. Arid regions and drylands, worldwide, are about 45 percent of the earth's land surface, have the highest carbon sequestration capacity at levels close to those of Europe's pine forests. Such dry lands possess the SOC sequestration capacity of around 1 Pg C year-1. These lands also account for 38 per cent of the global population as a whole.Soil erosion is the principal mechanism of soil degradation that removes carbon from the soil. Water and wind erosion is measured at about 1,094 Mha of land, worldwide. Soil erosion is an important compartment in global carbon budget calculation[18].

These lands also account for 38 per cent of the global population as a whole. Carbonate minerals are common in dry land soils world. The excessive salt and sodium content of soil negatively affects excessive soil properties calcium carbonate formation ($CaCO_3$).The amount of inorganic carbon in the soil (SIC) is two to three times greater as SOC in arid-semiarid area up to 1 meter deep. Our country has almost 229 million hectares of soil natural calcareous, and the role of SIC in carbon sequestration is important for soil fertility to be preserved. Indian bio-climatic zones such as semi-arid, sub-humid and humid in IGP have a SIC stock of 124.48, 12.28 and 24.11 Tg / lakh ha respectively. Interestingly, an earlier study found an indirect correlation between the SIC and SOC formation[19].

The low SOC and soil microbial biomass levels in salt-affected soil are attributed to low additions to substrates and decomposition rates. Initial estimates of SIC in our country's arid regions will encourage future research into the role of SIC in soil carbon sequestration.Soil erosion is the principal method of land degradation is removing carbon from soil. Globally, around 1,094 Mha of land has been estimated to be severely affected by water and wind erosion. Soil erosion is a critical container, though the global carbon budget is calculated. The estimated amount of soil carbon by flowing from degraded soil and wind is year-1 4–6 Pg C. Estimated in India ,air eroded carbon is 6 Tg C year-1. It is very important in Indian understanding of carbon loss from water / flooding. Even if there is a need management plan of action for forest covered land and crops are raised in India.There is an enormous amount of soil per year that in Himalayan and other mountains is eroded by water in Indian regions during monsoon season. Nevertheless to date, the source (from the source) is not clearly understated the definition of mountains and sinks (land / river / sea) gas[20].

- **Litter Decomposition and Microbial Population:**

The decomposition of plant litter is a dominant process in the flow in most terrestrial habitats, biomass and nutrients. The decomposition of litter is regulated by three factors: (1) the climate (2) The quality of the litter, and (3) the nature and abundance of the microbial cultures. Weather has a strong influence on decomposition of the litter by temperature impacts and humidity. Wet temperature and rainfall in the early stages, decomposition rates are higher. Early rates of decomposition are however strongly affected by chemical components of litter. Reportedly, SOM derived from lignin is susceptible to increased degradation at warmer temperatures[21].

Thus climate affects the storage of SOC by litter processes in decomposition. The bulk of the litter includes the structural components of the plant cell walls (cellulose, hemicellulose and lignin) and thus carbon are often in significant amounts larger than mineral concentrations. In addition to structural polymers, litter also includes water soluble components, such as simple sugars and amino acids, oils, waxes, basic and complex phenolic compounds and cutins. Many studies demonstrated the relationship amid the characteristics of litter quality and decomposition levels for a large number of plant species.The C: N ratio is recognized as a general quality index. The rate of mineralization tends to decrease with the C: N ratio increasing. The early decomposition stages are dominated by the carbohydrates easily decomposable, while at later stages lignin primarily regulates the rate of decomposition[22].

Soil microbes play a key role in the decomposition of litters protects. They release degrading enzymes which attack dead organic matter (OM), decomposing it into digestible units that can be used by them. Living in microbial for soil, the carbon content is less than 4% SOC. Macrobiotics

By continuous processing the population contributes carbon to the soil death and growth. They're land-sensitive practices of management, such as cultivation, forest degradation and rebounding. Citizens have always been interested in microbial necromancers' role (longer turn over time) in the stabilization of SOC[23].

It is stated that two separate groups of microbes (autochthonous and zymogenes) participate most of the time in the phases of decomposition / mineralization. Such two classes of microbes actively rely upon the availability of substrates. A zymogenic community of microbes flourishes with fresh inputs available and primarily metabolizes the labile fractions (cellulose and hemicellulose). When the fresh supply ceases it gets dormant. An autochthonous group of microbes will survive even if the supply stops being fresh.We primarily metabolize the recalcitrant fraction of SOM. The remaining SOM is stable for a longer period of time, after all these acts. Thus forms of microbial culture influence the storage / stabilization of SOC through the process of litter decomposition. There is still a shortage of knowledge about the microbial contribution to the long lived carbon pool in specific human habitats[24].

SOM (Soil Organic Matter) Models

Carbon sequestration in complex ecosystem soils could be possible estimated from direct carbon input measurements on the soil can be calculated on the basis of dynamic SOC models by litter fall, root decay and release by net mineralization or carbon sequestration in soil. Countless models exist based on their unique SOC dynamics objectivity.These models require carbon inputs for the falling soil by litter and decay by root and releasing of carbon by net mineralization to allow soil carbon measurement sequestration: Sequestration. The widely accepted Models of SOC CENTURY C & ROTH C. These two models initially are used primarily for agricultural soils and later on have also forest soils have been applied. The Middle-C Model SOM divided into three different pools, with different active (1–5 years), slow (20–40 years) and passive (400–2,000 years) residence times. Whereas the ROTH-C model has four functioning SOC compartments and a small amount of organic inert material (IOM)[25].

The four active compartments are decomposable plant material (DPM), resistant plant material (RPM), microbial biomass (BIO), and organic humidified material (HUM). Each compartment decomposes with its own characteristic rate through a first-order cycle. The IOM compartment is however resistant to decomposition. An earlier research had three distinct uses approaches (value cap, N-balance and SMART-2) to measure your net SOC sequestration rate.The most common model used to describe SOM's dynamic behavior or turnover is the first-order kinetic model that assumes a constant zero-order input with constant proportional mass loss per unit time. This model assumes the SOM is a single lake, and decomposed at similar velocities. It was after that calculated mineral soil carbon turnover time using the first-order decay model.Subsequently, It has been documented a four pool soil organic matter model accounting for carbon flow with linear kinetics model; they are fast, moderate, slow and stabilized. Not all the conceptual carbon pools used in these models are explicitly observable, as existing methodologies cannot specifically separate functional carbon pools with different residence time and stabilization mechanism[25].

SOC Pools: Separation by Various Fractionation Techniques:

SOM consists of different functional pools, which are stabilized use specific mechanisms and have some turnover rates. There are three principal techniques of soil fractionation (Physical, Particulate and Chemical) used for divide the SOC pools from the entire soil / aggregates to understand the Carbon Dynamics.

- **Physical Fractionation:**

Physical fractionation requires applying different types of dispersion (ultrasonic vibration in water), density of the disaggregating treatments (dry and wet sieving, slaking) sedimentation and separation. The detailed ways and the physical fractional techniques for calculating and understanding carbon conservation in forested soils have been published and widely used.

Each aggregate size was then subject to isolation the light and heavy carbon fractions, and finally the heavy fractions of all the aggregates were broken down further by Sieving Method into four carbon pools. Micro accessories ([250 lm) with organic compounds of different origin and stability are bonded together (\250 lm). Physical fractionation of soil particles into size and density classes can provide information about the importance of interactions between organic and inorganic soil components, as well as SOM turnover[26].

- **Density Fractionation:**

The fractionation of densities is absolutely dependent on isolation of SOM which is not strongly aligned with mineral component of soil. This technique may divide the SOM into small (LF) fraction, and high (HF). Defines light fraction as a plant-like and less stable low carbon fraction concentration, the heavy fraction being a more stable and organo-mineral high-density fraction with lower carbon focusing on. SOM linked to mineral surfaces like phyllosilicates are most often characterized by a density in excess of 1,6–2 g cm-3. The leaner fractions at a density of 1.6–2 g cm-3 mostly consist of parts of residues of plants as either SOM (POM) or free (fPOM) particulate matter or occluded in aggregates (oPOM). Historically fractional density relies on organic liquids, such as $C_2H_2Br_4$ tetrahedron, CCl_4

tetrachloride-methane, and inorganic salts include sodium iodide (NaI), and ZnBr2 polytungstate sodium which is increasingly used for separation fractions of LF and HF[27].

- **Chemical Fractionation:**

Unlike physical and particle scale fractionations, chemical most chemicals are used by fractionations (inorganic bases such as NaOH, and particularly hydrochloric and sulfuric acids used for extraction of large fractions of sugars from OM to SOM pools to extract. Normally extraction with 0.5 M NaOH removed more carbon and N from coarser fractions than from fine fractions. OM extracted with NaOH is not a homogeneous fraction of the soil, since the process of extraction influences interactions between organo-mineral and organo-organo at the same time. The residence time of recorded alkaline extracts varies generally and depends on the form of soil.

Acid hydrolysis is one of the chemical methods used to separate the older carbon from the whole soil by removing proteinaceous and polysaccharide type of organic materials. Hydrochloric acid (HCl)and sulphuric acid (H2SO4) are used to separate the old / recalcitrant from the whole soil. Lignin and waxes recently deposited may, however, be resistant to acid hydrolysis. Therefore, the approach to acid hydrolysis should concentrate on the old carbon stream, but can yield skewed results. The coarse fraction of SOC is usually less decomposed material and has a high C / N ratio than that of with low C / N humid composition[28].

The number of SOC pools and which techniques were used for sequestration varying from author to author. All of those methods have their own limitations. Hence the information on fractionation of SOC pool remains scanty and the techniques have not yet been developed was standardized in different soil types. The maximum aim of all those methods of fractionation is to separate the unobtrusive labile and recalcitrant carbon pool, and measure the size and rate of turnover of those baths, because the active / labile pool is more soil sensitive/ change in land cover, and temperature[29].

It specifically shows that a large proportion of the soil collected SOC forms a stable swimming pool. SOM are recognized as potential indicators of soil quality short-term changes due to shifts in management practices such as tillage, fertilizer and manure applications, and the rotation of crops. Special emphasis was given to the placed on fractions of SOM with high turnover, since these respond more quickly to management changes or environmental conditions if those pools change in the end, it will impact atmospheric CO2 levels. In overall, the stable SOC pool ratio increases with a rise in the depth of soil. The pattern has been observed teak, bamboo and dry deciduous forest soil mixed cover of vegetation in Gujarat, India. Nonetheless, information is required regarding the proportion of stable SOC pool for understanding other types of forest soils stable carbon dynamics, with global response weather change. This knowledge may be key for the future long term sequestration of SOCs[29].

- **Temperature Sensitivity of SOC:**

Approximately 60 per cent of total carbon is stored below ground global tropical and temperate forest ecosystems, whereas boreal forests account for 90 per cent of carbon below ground primarily in organic detritus form. Otherwise the higher temperature can lead to increased temperatures decomposition of biological detritus and releasing more CO2 It's been showed that the old, recalcitrant SOM decomposed or organic carbon is less temperature-sensitive in mineral soils carbon is labile[30].

Nevertheless, recent work on natural grassland revealed an acclimation trend whereby soil respiration sensitivity to warming decreases after the environment has been subjected to experimental warming for some time. The temperature sensitivity of SOM decomposition doesn't change with soil depth, sampling method, and incubation time according to the Fang group. The sensitivity of slow carbon pools to temperature is also higher than that of the quickest pools. The stabilized structure of SOM derived from lignin is therefore more likely to increase degradation at warmer temperatures. Hence a warmer or hotter temperature could reduce recalcitrant carbon storage.

- **Chemical Characterization of SOC:**

Various groupings of chemical compounds present in the SOC are mainly food, animal and microbial products derivatives. Significant plant tissue components are the polysaccharides, lignin's, tannins and proteins most of the bacteria and fungi are homo and hetero polysaccharides (chitin, peptidoglycan, lipopolysaccharides), Yet sugars, proteins yet animals contribute have lipids.The labile and recalcitrant carbon pool is characterized very important in studies of soil carbon dynamics. Biochemically recalcitrant SOM fractions are enriched by an alkyl group of carbon structures and the alkyl carbon ratio and the average age of SOM increases with a rise in soil depth. Consequently, understanding the chemical nature of the SOC pools is very important particularly in deeper layers of the carbon stabilization cycle[31].

- **Carbon Isotopes in the SOC Dynamics Study:**

Further researchers have used the radiocarbon dating process along with some of the fractionation techniques (physical, particulate and chemical) for the last one decade to measure the age of the Boreal, Temperate and SOM pools tropical wildlife. Carbon isotopes are extremely useful tracers in soil carbon cycle analysis. Since, during photosynthesis, plants take carbon by two separate mechanisms in the form of carbon dioxide.An earlier study used the combination of carbon labeling with natural carbon abundance to distinguish between the three carbon sources in CO2, microbial biomass and dissolved organic carbon (DOC), and also to evaluate the mechanism and sources of priming effect. There is still a lack of understanding of the concept of "the priming effect" by adding fresh litter in different types of soils under different depths vegetation types cover the natural field conditions[32].

- **Interaction with Soil Minerals:**

Clay minerals are distinguished by the small grain size and large surface area. Because of large surface area it greatly adsorbs the organic matter. It is usually associated with soil with higher clay content. The strong bonding of organic anion with clay crystals due to the behavior of the multipurpose cations avoids organic matter from microbial degradation. It is also believed the importance of clay in keeping SOC across borders soils are influenced by compositional mineralogy. Oxide Fe and Al on the mineral surface of clay give minerals of clay a capacity for OM adsorption.Several studies have also reported that Fe oxides play an important role in stabilizing the carbon in various soils. Original study has direct relationship between HF soluble fraction (mineral fraction related, stable fraction) and Fe oxides that enriched with clay fraction was found. SOC associated with different clay minerals with respect to different types of soils and the relative importance of such clay minerals for stabilizing SOC remains unclear[33].

Conclusion

Understanding SOC pools and the mechanisms / processes involved in converting sequestered carbon into pool labile / stabilized in different soil types under different conditions covering vegetation is also a difficult activity. Since then there's no uniform or can fractional technique separating labile and recalcitrant carbon reservoirs into similar soil forms under common cover of vegetation, understanding labile and/or recalcitrant susceptibility pool of carbon in soils is quite different to climate factors contestable.Therefore, the synthesis of various fractions various forms of methods will be used soils for solving those problems. The NMR combination and carbon isotope technique is the best choice understand how labile or recalcitrant carbon is and its turnover rates. India is amongst developed nations more vulnerable to the current global climatic change due to the rapid development of industrialization and urban development settlement in fertile forest / farmland. The increase inorganic carbon content even in Indian agricultural soils arid, semi-arid areas need special attention investigators in India.

Current carbon study agenda sequestration must occur in soil or other habitats many different disciplines and have common objectives such as measuring the size, dynamics and labile turnover and recalcitrant carbon pool (secured by woodland, farming land in various climatic zones and plantations) in all ecosystems other than to estimate the fossil reserves of different ecosystems. The promotion of work on SOC sequestration services in depleted lands of India will be advantageous for the government and other stakeholders to boost the biodiversity, food security and carbon credits trading. Also understanding their vulnerability to various factors including physical, biological and anthropocentric is very important as the soil – plant system is an integral part of the planet earth.With the rapid growth of industrialization and urbanization in fertile forest / agricultural land, India is more vulnerable to the ongoing global climate change among developing nations. In addition to arid and 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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