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Climate Change Combat – A Conspectus

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Abstract

Climate change is one of the major issues, which is currently threatening several ecosystems and affecting the livelihoods. Climate change could happen due to natural and/or anthropogenic causes, although the latter has acted as a key trigger in the last few decades. Climate change and global warming are mainly due to the emission of greenhouse gases, of which carbon dioxide is one of the predominant greenhouse gases and several initiatives have been undertaken to reduce its emission and by sequestering it in different carbon pools. Oceans and forests are considered to be important carbon reservoirs in aquatic and terrestrial ecosystems respectively. In forests, carbon is largely stored in vegetation biomass, especially that of trees and soil. Alongside the implementation of carbon mitigation programmes, various databases have also been compiled. However, to effectively combat climate change, it is essential to reach out and spread awareness to the general public and vulnerable sectors, urging them to minimize their individual carbon footprints.

Keywords: Climate Change; Carbon Mitigation; Blue Carbon; Forestry; Carbon Footprint

Abbrevations: UNFCCC: United Nations Framework Convention on Climate Change, CO_2: Carbon Dioxide, °C: Degree Celsius, ppm:Parts Per Million, Pg C:Petagrams of Carbon, REDD: Reduced Emissions from Deforestation and Forest Degradation, REDD+: Reduced Emissions from Deforestation and Forest Degradation Plus, CER: Certified Emission Reduction, EDGAR: The Emissions Database for Global Atmospheric Research

Introduction

Climate change is an on-going phenomenon, which exerts a profound influence on several ecosystems worldwide, and as a result threatens the livelihoods of people, either, at present or in the near future, especially those from the developing nations that are particularly vulnerable. As defined by United Nations Framework Convention on Climate Change (UNFCCC), climate change is "a change of climate which is attributed directly or indirectly to human activities that alter the composition of the global atmosphere and which are in addition to natural climate variability observed over comparable time periods." In simple words, it could be defined as "any systematic change in the long-term statistics of climatic elements (such as precipitation, temperature, humidity, pressure, winds, etc.) that are sustained over several decades or longer." Climate change could thus be the resultant of natural or anthropogenic triggers, albeit in the recent past, the latter has proven to be a major factor.Climate change and global warming is greatly driven by the emission of greenhouse gases into the atmosphere such as carbon dioxide (CO_2), methane, nitrous oxide, ozone, hydroflourocarbons, chlorofluorocarbons, etc. It is supposed that the carbon fluxes during the pre-industrial times remained largely in balance, but with the onset of industrial revolution in 1800 [1], the greenhouse gases were emitted in an unprecedentedrates. Thus, the Earth has now entered the Anthropocene epoch [2-4]. Deforestation, fossil fuel combustion, land use change, land degradation [5,6], urbanization, overexploitation of natural resources, etc. are some of the primary anthropogenic causes that have quickened the pace of climate change. The global temperature was 0.71°C higher than the 20th century average of 12°Cas on January 2018 [7]. As warned by UNFCCC, it is estimated that the Earth could warm up anywhere between 1.8°C and 4°C by 2100 and this increase in global temperature could lead to thermal expansion of the oceans and lead to sea level rise. It has been projected that the sea level rise would be 0.18-0.59 metres by 2100. Besides these, climate change and global warming could significantly alter the type, frequency and intensity of weather events such as cyclones, droughts, floods, etc. and some of these have already been witnessed [8]. Intense heat waves could drastically impact crop production and cause the outbreak of several diseases. These dire consequences of climate change could in turn, disrupt the natural balance further [9].

Carbon Sequestration

Among the different greenhouse gases, carbon dioxide is an important greenhouse gas, the concentration of which in the atmosphere is on an alarming rise. The concentration of CO_2

as on May 2018 is 411.31 ppm [7]. Absorbing carbon from the atmosphere and containing the same in different pools on earth is the most effective way of combating climate change, also known as carbon sequestration. Carbon sequestration could be defined as "the process of "transfer and secure storage of atmospheric CO2 in long-lived pools, which would otherwise be emitted or remain in the atmosphere" [6,10]. Carbon sequestration takes place in both aquatic and terrestrial ecosystems.

Aquatic Ecosystem

Of the different aquatic habitats, the oceans play a major role in absorbing and stocking atmospheric CO_2, which thus becomes 'blue carbon'. This blue carbon acts as a "buffer to climate change" [11]. The world's oceans are estimated to absorb around 2 billion tonnes of carbon, which would make up for about 25% of the global annual anthropogenic emissions [12-14]. Besides storing carbon in the biomass of the marine biota such as algae, bacteria, etc., the oceans have an intrinsic capacity to accumulate and store carbon in the sediments for several millennia, without getting saturated [15,16]. Carbon sequestration is often one of the primary reasons behind the coastal management and conservation programmes.

Terrestrial Ecosystem

Carbon sequestration in terrestrial ecosystems has gained widespread attention, especially among researchers, land managers and foresters, who actively look for ways to enhance their carbon mitigation potential. Carbon sequestration occurs in varying capacities in different terrestrial ecosystems, such as agricultural lands, plantations, urban greeneries, natural forests, abandoned lands, etc. However, natural forests are the most efficient carbon absorbers of the different land uses. The global forest carbon accumulation was estimated to be 1.1 ± 0.8 Pg C/year [17]. Different forest types have different patterns of carbon sequestration. For example, the tropical forests store 56% of carbon in their biomass and 32% in soil, while the boreal forests store only 20% of carbon in biomass, but 60% in soil. Overall, the tropical forests store 55% of world's forest carbon, followed by boreal and temperate forests, which store 32% and 14% respectively [17].

It is apparent that the forests store carbon in different pools, each being unique. Principally, there are six different carbon pools - aboveground trees, aboveground non-tree vegetation, belowground roots, forest floor litter, dead wood and soil organic matter [18]. In forests, the atmospheric CO_2 is absorbed by plants via photosynthesis and is released back to the atmosphere during respiration. The plant parts, such as wood, roots and the leaf litter return back to the soil and the carbon is again released back to the atmosphere via the processes of respiration and decomposition by heterotrophic organisms [19]. Vegetation biomass and soil are the predominant carbon reservoirs in a forest. In trees, the atmospheric carbon that is fixed by photosynthesis is then transferred to its different organs such as trunk, branches, leaves, reproductive parts, roots, etc. [20,21]. The tree trunk, which is rich in lignin is an important compartment of the biomass carbon [22]. Large trees are often regarded as persistent carbon sinks as these keep stocking atmospheric carbon for several decades and even upon death, the rates of decomposition and carbon release are very slow [23]. Soil is a large and dynamic carbon pool that has the potential to store twice the collective amount of carbon stored in the atmosphere and biosphere [24,25].Of the world's soil carbon pool, two-thirds are constituted by the organic carbon, while the rest is held as inorganic carbon [26,27]. Soil organic carbon represents the balance between carbon inputs (from plants) and carbon outputs (by decomposition) and is a continuum of intact plant parts to highly oxidized forms of carbon [28,29]. Soil organic carbon is further categorized into three pools – active pool (labile carbon, comprised of fresh plant and animal parts, which breaks down in a few weeks to few years), passive pool (non-labile carbon, that takes centuries and millennia to get fully decomposed) and slow pool (intermediary stage between the active and passive pools) which have different turnover times [30,31]Recognizing the importance of stocktaking of carbon stored in global forests, several programmes were initiated. The UNFCCC initiated the Reduced Emissions from Deforestation and forest Degradation (REDD) and REDD+ programmes to provide economic incentives to the developing countries that are forest-rich, who would enhance the carbon stocks to compensate for the emissions of CO2 by other nations, that are usually developed [32,33]. A carbon credit, also known as a Certified Emission Reduction (CER) is a permit that allows an organization or a country to emit certain amounts of carbon which could be traded to another organization or country that offsets the emission through forestry or restoration projects. Apart from implementing various carbon mitigation programmes, several datasets on carbon emissions, biomass and carbon stocks have been compiled, such as: BIOMASAR (http://www.biomasar.org/)[34], GEOCARBON Data Portal (https://www.bgcjena.mpg.de/geodb/projects/Home.php)[35], The Emissions Database for Global Atmospheric Research (EDGAR) (http://edgar.jrc.ec.europa.eu/overview.php?v=CO2andGHG1970-2016&sort=des9#)[36], Global Forest Ecosystem Structure and Function Data for Carbon Balance Research (https://daac.ornl.gov/VEGETATION/guides/forest_carbon_flux.html)[37].

Conclusion

Although climate change is a widely discussed topic in the present days, ways to combat the same have not gained enough outreach yet. Spreading awareness and capacity-building to mitigate and slow down the consequences of climate change is the need of the hour, especially among the vulnerable sections in the developing nations. Also, on an individual level, appropriate eco-friendly measures ought to be taken to minimize the carbon footprints. To conclude, awareness and appropriate steps to enhance carbon sinks and prevent sinks from becoming sources

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could be the important means to effectively combat climate change.

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