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Carbon sequestration – Need of the hour

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Carbon sequestration, the long-term storage of carbon in plants, soils, geologic formations, and the ocean. Carbon sequestration occurs both naturally and as a result of anthropogenic activities and typically refers to the storage of carbon that has the immediate potential to become carbon dioxide gas. In response to growing concerns about climate change resulting from increased carbon dioxide concentrations in the atmosphere, considerable interest has been drawn to the possibility of increasing the rate of carbon sequestration through changes in land use and forestry and also through geoengineering techniques such as carbon capture and storage. Natural carbon sequestration is a cycle that's been happening on this planet for billions of years. It's simply the process by which nature has achieved a balance of carbon dioxide in our atmosphere suitable for sustaining life. Animals expel carbon dioxide, as do plants during the night; forest fires belch carbon dioxide into the atmosphere, volcanic eruptions and magma reservoirs deep beneath the ground also play their part. With all this carbon dioxide being pumped into the atmosphere, there needed to be a way of removing it otherwise the surface of the planet would rapidly overheat.

Nature provided trees, the oceans, earth and the animals themselves as carbon sinks, or sponges. All organic life on this planet is carbon based and when plants and animals die, much of the carbon goes back into the ground where it has little impact on contributing to global warming. Many tree planting programs have been initiated over the years; originally to assist with preventing erosion, loss of biodiversity and desertification, but increasingly the benefits of these program are focused around their carbon dioxide sequestration benefits. The problem is, we've removed so many trees from this planet over the last couple of hundred years, it's going to take some time before the millions of trees planted in the last couple of years mature enough to provide sequestration benefits. Still, it's great to see the added impetus on tree planting.

Humans are odd creatures - we like to dig stuff up, make it cause havoc and then try to bury it again - out of sight is out of mind. Coal and oil are great examples. We rip up the earth to get to these resources and then burn them which causes massive amounts of carbon dioxide to be released, causing global warming. Instead of rapidly discontinuing the use of what we know is heating our planet, researchers are trying to find other ways of defeating Nature to allow us to continue our lifestyles; or helping it deal with the excess carbon dioxide we produce - how you view the situation is up to you. Artificial carbon sequestration refers to a number of processes whereby carbon emissions are captured at the point of product and then, well, buried. One proposed method is ocean sequestration whereby carbon dioxide is injected deep into the ocean, forming lakes of CO_2. In theory, the carbon dioxide will stay down deep due to the pressure and temperature of the surrounding water; gradually dissolving into that water over time. Another method is geological sequestration where the carbon dioxide is pumped into underground chambers such as old oil reservoirs, aquifers and coal seams that are unable to be mined. Mineral sequestration is also being considered. In this method, carbon dioxide is injected into areas rich in Magnesium or Calcium. The carbon dioxide will react with those elements and combine to form calcium carbonate (limestone) and magnesium carbonate (magnesite).

Forest Ecosystems exchange energy, water, and nutrients and, in particular, carbon(C) with surrounding ecosystems, and play a major role in the global C cycle. Forests are major terrestrial C sinks, have large C densities and sequester large amounts of atmospheric carbon dioxide (CO2). By various natural processes, C is entering forest ecosystems in dissolved, gaseous and particulate form. The C is temporarily stored, and sequestered in above- and belowground pools in vegetation, detritus and soil. Efflux processes result in C losses to adjacent ecosystems. This chapter describes C in- and efflux processes, the C turnover within forest ecosystems and how C is sequestered in the different forest ecosystem pools with a focus on processes occurring in trees and soil. Carbon fixed recently by photosynthesis is subsequently translocated and partitioned within the various compartments in trees. In forest trees C is used for growth, defense, reserves, accumulation, and storage. Carbon sinks within the tree are located, in particular, in immature foliage, stems and branches, reproductive organs, and roots. Tree stems contain the largest pool of C in form of wood, and lignin is richest in C. A fraction of the C assimilated byphoto-synthesis is exported from the tree to mycorrhiza and soil microorganisms.

The predominant forest types of India are tropical dry deciduous and tropical moist deciduous. Tropical forests have a strong vertical structure, with much of the leaf biomass and fruits in the brightly lit canopy, and seed germination, seedling growth, and juvenile recruitment in the dark understory. Tropical forest canopies have a layered structure. Tall trees comprise the upper layer, followed by a main canopy layer, and a subcanopy of smaller trees and shrubs near the ground level. Trees in tropical forests have relatively large leaves and are often characterized by buttresses, and palms, climbing plants, epiphytes and hemi-epiphytes. In contrast to tropical evergreen forests, tree species diversity is lower in tropical deciduous forests. Furthermore, canopies are shorter and the structure is more open compared to the tropical rainforests. Epiphytes, ferns and herbs contribute much less to total Leaf Area Index (LAI) of tropical rainforests compared to trees, palms and lianas. Trees are often the most important functional group followed by palms and lianas. The average LAI for tropical deciduous broadleaf forests is 3.9 whereas it is 4.8 for tropical evergreen broadleaf forests. Tropical forests contain more than half of the Earth’s terrestrial species. Furthermore, tropical forests predominantly contribute to global biodiversity ‘hotspots’ or areas featuring exceptional concentrations of endemic species and experiencing exceptional loss of habitat. Biodiversity is generally high but little is known as tropical forests are extensive, highly variable and generally more difficult to study than any other vegetation type. About44% of the world’s relatively undisturbed forest lies in the tropics. The most dramatic changes in tropical forest ecosystems involve rapid conversions to other land uses. Old growth tropical forests contain large pools of C, and account for a major fraction of the global Net Primary Productivity (NPP). Changes in tropical forests may, thus, have significant effects on the global C balance. The global CO2 flux caused by the land use changes, however, is dominated by tropical deforestation as about 13 million hectare tropical forest are felled or grazed each year (FAO2006). In summary, undisturbed tropical forests are responsible for ca. 27% of the global terrestrial C sink . Wood growth, in particular, accounts for 50% of the sink. Carbon pools are large and diverse and plant biomass is the major C pool in tropical forests. Rates of C cycling are high. Tropical humid evergreen forests retain, for example, only ca. 12% of the C fixed by photosynthesis. Large uncertainties, however, exist for the belowground C pools and dynamics. The C-use efficiency is intermediate compared to other forest types. ENSO (El Niño-Southern Oscillation) is the major natural and both deforestation and fire the major anthropogenic disturbances of the tropical forest C pool. Whether or not a C sink exists in the tropics is, however, highly uncertain. Also, the importance of a long-term C sink in wood is a matter of debate. However, C sequestration in soils and organic matter is an important process in tropical humid forests. Woody biomass can substitute fossil fuel based products for heat and power generation, and contribute to mitigation of Abrupt Climate Change (ACC) by forest land use. Source for woody biomass are forest residues, and dedicated bioenergy tree plantations. Conventional breeding techniques and biotechnology are used to improve the properties of high-yielding bioenergy trees. A major challenge for cellulosic ethanol production from woody biomass is to overcome the barrier of lingo cellulosic recalcitrance. Negative impacts of large-scale plantations on soil nutrients and on the hydrological cycle must be minimized to ensure sustainable use of woody biomass as renewable energy source. Enhancing forest C sequestration has not been achieved under the Kyoto Protocol. Several approaches are discussed for reducing C emissions from deforestation and degradation which will be included in future international agreements on ACC. Forest C accounting and monitoring systems are required to assess the success of C cap-and-trade mechanisms by forest land-use and deforestation, especially, in the tropics. Future C sequestration in global forest ecosystems maybe determined by human activities such as tropical deforestation, and exploration of peatland and old-growth forests. Further studies regarding reproduction biology of high carbon sinking species of plants needs to be undertaken so that they can be propagated in large number.

Reference:

1. https://www.nrsc.gov.in/Forest_Types
2. Lorenz, K. and Lal, R. (2010). “Carbon Sequestration in Forest Ecosystems”. Springer publications. DOI 10.1007/978-90-481-3266-9. pp 193-261.