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A REVIEW ON CARBON SEQUESTRATION (NON-DESTRUCTIVE METHOD) IN URBAN ECOSYSTEM

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ABSTRACT

Vegetation serves several critical functions in the biosphere, at all possible spatial scales. First, vegetation regulates the flow of numerous biogeochemical cycles, most critically those of water, carbon, and nitrogen; it is also of great importance in local and global energy balances. Such cycles are important not only for global patterns of vegetation but also for those of climate. The results of the vegetation study can be accompanied by other ecological parameters to assess the changes occurring in the local ecology The results may further be utilized to study the capability of the vegetation cover to mitigate the harmful effects of pollution¬ the results of the study may further be utilized to create a framework for planning and developing urban areas having higher carbon mitigating capabilities.Trees absorb Carbon dioxide from atmosphere and stored by photosynthesis, balancing the atmospheric Carbon dioxide in form of Carbon as Biomass. Rapid urbanization, Industrializing and imposes grand societal and environmental challenges such as compromised human health, alternation of local and emission by Using diverse types of land use pattern in increase the carbon sink of Forestry. The role of trees in the Forest In carbon cycles quite predictable (Singh & all, 2000) Regional climate, loss of natural habitats and biodiversity and degradation of water and Air quality. In recent decades, there has been much research accompanying quantifying the C sequestration of Urban Forests (Pataki et al., Zhao. Zhan et al. Accurate quantification of the Carbon storage in various in various urban forest is critical to improving our understanding of the role of urban green space in the urban carbon balance. Carbon sequestration estimation done by various methods like, Estimation of Tree volume, Above Ground Biomass, Below Ground Biomass, Total Biomass, Total Carbon Content, Determination of weight of Carbon dioxide sequestration in the Tree etc.

Key Words: Carbon stock, Carbon Sequestration, Non-Destructive methods. Urban Ecosystem

INTRODUCTION

All living things contain the chemical element known as Carbon, which is regarded as the essential component of life. It is mainly found in soil as organic matter and plant biomass in many different forms. Trees absorbs carbon dioxide during the photosynthesis process, and they accumulate the residual carbon to store it as biomass. Trees serve as a carbon dioxide sink. Carbon is stored in a variety of natural stocks, including the atmosphere, fossil fuel deposits, terrestrial ecosystem and oceans. In the terrestrial environment, carbon is stored in rocks and sediments, wetlands and forest grassland and agricultural land. The most often produced greenhouse gas is carbon dioxide. The technique of removing and storing carbon dioxide from the atmosphere is known as carbon sequestration. It can lessen atmospheric carbon dioxide, which can lessen the escalating effects of global climate change brought on by emission from fossil fuels. It is an organic, naturally occurring process that is a part of the carbon cycle. Carbon dioxide is discharged into the atmospheric as carbon monoxide;

therefore, carbon sequestration is the long-term storage of carbon in various biological and aquatic ecosystems. The geological and biological forms of carbon sequestration are being evaluated by the United States Geological Survey. The basic goal of is to maintain carbon in its solidified and dissolved forms in the best possible stability, preventing it form absorbing heat from the atmosphere. It might help to reduce carbon footprints. By figuring out how much carbon a tree can store, we can plant additional trees that can store more carbon. So, it is essential to focus on increasing carbon in sink and reducing carbon output. More carbon dioxide is transformed into biomass when photosynthesis happens more frequently in plants.

CARBON SINK

Carbon sink naturally remove carbon from the atmosphere. More carbon is removed from the atmosphere by carbon sinks than is put back in. the three primary carbon sources cause the atmosphere to release carbon dioxide. Example of carbon sources includes the combustion of fossil fuels like gas, oil and coal, volcanic eruption and deforestation. More carbon is being released into the atmosphere than the planet's natural carbon sinks can take in as a result of our energy. Tones of carbon are emitted into the atmosphere every year. Forest is one type of natural carbon sink because they store more carbon than they emit during photosynthesis. Every year, 2.6 billion tons of carbon dioxide is absorbed by forest all around the world. The process of storing atmospheric carbon dioxide in the soil is known as soil carbon sequestration. Plants moderated the process by using carbon that is stored as SOC during photosynthesis (soil organic carbon). Due to phytoplankton in the ocean it is one of the largest carbon sinks. The primary drivers of the global carbon cycles, which removes the same amount of carbon from the atmosphere as all land plants and trees combined are microscopic marine algae and bacteria.

CARBON SEQUESTRATION

Carbon sequestration is long term carbon storage in ocean, soil, vegetation and geological formation. In nature, forest ecosystem act as a reservoir of carbon. They store huge amount of carbon and regulate the carbon cycle by exchange of CO2 from the atmosphere. Forest ecosystem is the one of the most important terrestrial carbon sinks. They uptake CO2 through photosynthesis and store carbon in their tissue, forest litter and soil. Thus, forest ecosystem plays important role in the global carbon cycle by sequestering a substantial amount of carbon dioxide from the atmosphere. Carbon sequestration in urban ecosystem More than half of the world's population now lives in urban areas and this figure will continue to increase at a rate of 4% a decade by 2050. Rapid urbanization imposes grand societal and environmental challenges such as compromised human health, alteration of local and regional climate, loss of natural habitats and biodiversity and degradation of water and air quality. It is widely believed that forest patches in urban areas provide many ecological and social benefits, which partly mitigate urbanization-caused deterioration of the environment. Thus, more studies are needed to precisely assess each ecosystem service provided by urban forests and undoubtedly communicate the scientific findings. Urban Cities are responsible for ~75% of global anthropogenic carbon dioxide (CO2) emissions. An interesting research topic is to quantify and understand the role of conserving or increasing carbon (C) stored within urban areas themselves in offsetting anthropogenic CO2 emissions generated from cities. Urbanization drastically alters the ecosystems services, structure and functions, disrupts geochemical cycle and other elements along with water. It alters the energy balance and influences climate at local, regional and global scales. In recent decades, there has been much research accompanied to quantify the C sequestration of urban forests. For example, -estimated that a substantial amount of carbon was stored within above ground vegetation in Leicester, United Kingdom, and that trees account for more than 95% of this carbon pool. In some regions, especially arid areas, urban forests may store more carbon than adjacent suburban and rural areas, as a result of tree planting and urban green space management. Judicious planning with effective management can augment C pool in urban ecosystems, and off-set several of the anthropogenic emissions. Therefore, accurate quantification of the C storage in various urban forests is critical to improve our understanding of the role of urban green space in the urban carbon balance.

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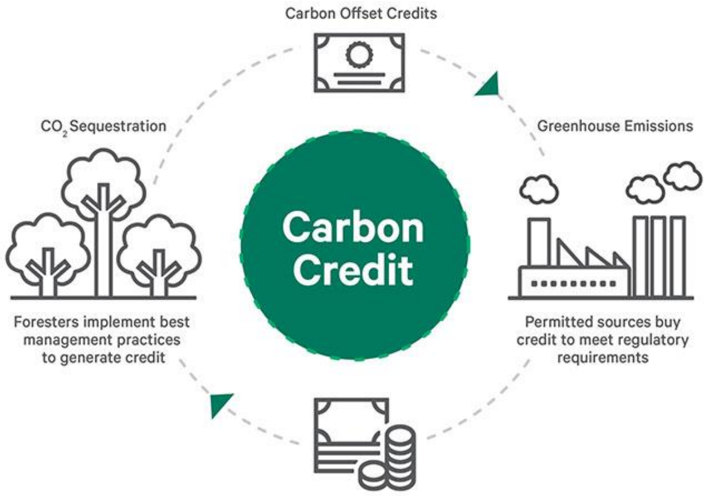
CARBON CREDIT

It is a cap and trade system. A carbon credit is a kind of permit that represents 1 ton of carbon dioxide removed from the atmosphere. They can be purchased by an individual or, more commonly, a company to make up for carbon dioxide emissions that come from industrial production, delivery vehicles or travel.



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REVIEW OF LITERATURE

Carbon is the most essential element on the earth which is present in all living form and in dead organic elements of animal and plants. Carbon sequestration is the phenomenon for the storage of carbon dioxide (CO2) from the atmosphere to mitigate global warming (Gazioğlu et al., 2015; Gazioğlu and Okutan, 2016).

Plant can store carbon in their biome as long as they live Plant have ability to sequester carbon and reduce environment pollution. Tree canopies provide a cooling effect on microclimate specifically by shading the ground surface and indirectly through transpiration (Subedi, et.al, 2010).

Forest ecosystem plays important role in the global carbon cycle by sequestering a substantial amount of carbon dioxide from the atmosphere. (Gavali and Shaikh, 2016).

Carbon sequestration in urban ecosystem More than half of the world's population now lives in urban areas, and this figure will continue to increase at a rate of 4% a decade by 2050 (UN, 2015).

In 2050, 70%of the world population will live in urban centres and number of megacities (10 million inhabitants) increased from three in 1975 to 19 in 2007, and is projected to be 27 in 2025. (Rattan and Augustin, 2013).

Rapid urbanization imposes grand societal and environmental challenges such as compromised human health, alteration of local and regional climate, loss of natural habitats and biodiversity and degradation of water and air quality. It is widely believed that forest patches in urban areas provide many ecological and social benefits, which partly mitigate urbanization-caused deterioration of the environment. Thus, more studies are needed to precisely assess each ecosystem service provided by urban forests and undoubtedly communicate the scientific findings. Urban Cities are responsible for ~75% of global anthropogenic carbon dioxide (CO2) emissions (Seto et al., 2014).

There has been much research accompanied to quantify the C sequestration of urban forests (Pataki et al., 2006; Zhaoet al., 2013).

For example, - estimated that a substantial amount of carbon was stored within above ground vegetation in Leicester, United Kingdom, and that trees account for more than 95% of this carbon pool. In some regions, especially arid areas, urban forests may store more carbon than adjacent suburban and rural areas, as a result of tree planting and urban green space management (Nowak, et al., 2013).

Plants modify temperatures by changing the rate at which energy is exchanged (Mastalerzand Oliver 1974).

The existence of well-distributed and abundant vegetation cover in cities can provide many benefits for city dwellers. The most obvious benefit to the public is aesthetic. Trees, shrubs, and lawns add natural colour, shape, and texture to the rectilinear concrete and asphalt surfaces in cities and conceal unpleasant spots from view (Miller, 1997).

In recent years, researchers have been looking into another potential benefit of greenspace and vegetation — improvements to public health —but a clear consensus has yet to emerge. A 2011 systematic review found that there is only "weak evidence for the links between physical, mental health and well-being, and urban green space." The study showed a beneficial association between exposure to green space and cognitive development among schoolchildren that was partly mediated by reduction in exposure to air pollution (Dadvand, 2015). Urban trees can help to mitigate some of the negative impacts and social consequences of urbanization, and thus make cities more resilient to these changes.

MATERIAL AND METHODS

Several studies have approved a number of carbon estimation techniques.

Clinometer:
With the use of a tool called a clinometer and the triangulation theory, tree heights are measured. It is a simple instrument to measure the angle of a slope. In which two measurements must be taken: first to the bottom of the tree which will be a negative number on the scale & second to the top of the tree which will be a positive number. The overall height of the tree will be the measurement of both (the bottom + the top).

Quadrate sampling:
The quadrate techniques are used to calculate the population and species density in a community. The plot technique is another name for the quadrate sampling approach. The clean development mechanism for projects including afforestation and reforestation that have been approved by the Kyoto protocol is used to plan projects.

Theodolite:
It becomes important to measure horizontal and vertical angles more precisely when the objects are at a great distance or are located at a great height or depression. A device called a theodolite is used to measure these distances.

Stick method:
Using a garden stick is a quick and fairly accurate way to gauge the height of a tree. The tree height is the distance from the tree's base to its highest point on the ground. At breast height, or GBH (girth at breast height) which is around 12 feet above the ground, a tree's circumference is measured.

Remote sensing:
To get the border of the trees, filtered LiDAR data and Quickbird photos are segmented using a watershed segmentation approach based on mathematical morphology. Using sensors, the highest point in each canopy items is utilized to calculate the estimated tree height.

Methodology for the Carbon stock Assessment
Carbon sequestration potential of the total number of enumerated trees will be calculated using specific annual biomass increment, area under tree cover, default average above ground biomass growth factor, Estimation of Tree volume.

The following formula was used to estimate the tree's volume
$\mathbf{V = \pi r^2 h}$
Where, (V = Volume, r^2= Radius, h = Height) in cubic meter (cm^3).

Calculation of Above Ground Biomass (AGB)
AGB (kg/tree) = Volume of tree (m^3) × Wood density (kg/m^3) Note: if the wood density is unavailable, the computation is done using the Standard average value of 0.6 gm/cm^3.

Calculation of Below Ground Biomass (BGB) The total biomass of living roots, excluding fine roots with a diameter of less than 2 mm, is referred to as below ground biomass. As the root: shoot ratio was provided by Ravindranath and Ostwald (2008) in their technique, the below ground biomass was estimated by multiplying the above ground biomass by 0.26 factors.

BGB (kg/tree) or (ton/tree) = AGB (kg/tree) or (ton/tree) × 0.26
Where, 0.26 = Root to Shoot ratio Total Biomass The total biomass is the addition of the above and below ground biomass as described by Sheikh, et al. (2011), According to him

Total Biomass Total Biomass (kg/tree) = AGB + BGB

Total Carbon TC = TB/2 or TB×50%

Determination of the weight of carbon dioxide sequestered in the tree Carbon dioxide is formulated by three molecules which include one molecule of carbon and two molecules of oxygen. The atomic weight of carbon is 12 and of oxygen is 16. The weight of carbon dioxide is 44. CO_2 = 1C + 2O = 1(12) + 2(16) = 44The ratio of CO_2 to carbon is 44/12 = 3.667

Materials Required Primary data:
Satellite Imagery from Google earth Pro Landsat 8 ensures the continued acquisition and availability of Landsat datautilizing a two-sensor payload, the Operational Land Imager (OLI) and the Thermal InfraRed Sensor (TIRS).
LISS 3 and LISS 4 imagery from Bhuvan Resourcesat-2 is a follow-on mission to Resourcesat-1.
The new satellite provides the same services as the original RESOURCESAT-1, but was also designed to "providedatawith enhanced multispectral and spatial coverage" The satellite contains 3 multispectral.
The Linear Imaging Self-Scanning Sensor (LISS-III) with 23.5 meter spatial
• Advanced Wide-Field Sensor (AWiFS) with 56 meters spatial resolution.
• cameras on board. resolution S-AIS (Satellite-based Automatic Identification System) for tracking maritimetraffic in Indian Ocean Search
• Rescue Region LISS-IV Camera with 5.8 meters spatial resolution.
Secondary data:
1. Satellite maps and Administrative boundary maps of the cities
2. Base maps of the study area Carbon Stock Assessment

RESULT AND DISCUSSION
The biomass of trees was estimated on the basis of GBH (Girth at Breast Height) and tree height. The randomsampling method was used for sampling the trees for estimation of above groundbiomass. The GBHs of trees having diameter greater than 50cm were measured directlybymeasuring tape and height of the trees were measured by clinometers, Quadrant methodwas used to measure the GBH, above ground biomass (AGB) and below ground biomass (BGB) of dominant species.

The total Biomass of trees was calculated using following equation: Total Biomass (ton/tree) = AGB + BGB Estimation of Carbon Storage. Generally, for any plant species 50% of its biomass is considered as carbon. The carbonof trees was calculated using following equation. Carbon store = Biomass×50%or =Biomass /2 25 5.

On average one tree in Gujarat may store about 207 kg carbon against India's average of 208kgc/tree and has been estimated 7.86 kg C/tree/year of the tree in India, although it depends on size and species of the tree. The stored carbon in tree cover of Gujarat is about 1.3mt and present annual carbon sequestration rate is 49,500 carbon ton, which may increaseiftree cover improves as planned by state. The Green cities In India, Gandhinagar, Chandigarh, Bangalore, New Delhi, Guwahati, Bhubaneswar, Dehradun and Shilong cities having good tree cover and natural environment. FSI estimated 11.9% of geographical area under tree and forest cover in Delhi and 14.9%inChandigarh. The good tree cover in Gandhinagar 53.9% is highest among all citiesinIndia. Bhavnagar and Vadodara have good tree cover (above 15%of geographical areaand tree density mot-re than 30 tree/hac). The average tree cover in the 20 metropolitan areas in USA has been estimatedtobeabout 27.1 % of the geographical area. In Japan, average tree crown coverage was about 18 26.74% in urban and suburban area. Average woodland cover has been estimated18.5%of the geographical area within municipal limit of 26 Large European cities (Wanget al, 2004 and Yang et al, 2009). There is no authenticate information that rank green cities of the world, but the tree cover in Gandhinagar is at par with at in Atlanta city, which has highest tree density in USA. Atlanta is being called 'City in Forest' due to its abundance of tree,

CONCLUSION

A substantial amount of carbon was stored within above ground vegetation, and that trees account for more than 95% of this carbon pool. In some regions, especially arid areas, urban forests may store more carbon than adjacent suburban and rural areas, as a result of tree planting and urban green space management. Judicious planning with effective management can augment C pool in urban ecosystems, and off-set several of the anthropogenic emissions. Therefore, accurate quantification of the C storage in various urban forests is critical to improve our understanding of the role of urban green space in the urban carbon balance.

These drastic differences between urban and natural systems suggest that characterizing C dynamics of urban forests is an important component of the carbon cycle science. The outcomes would increase the knowledge base for researchers and planners working in the field of urban ecology and urban planning. The estimation of the carbon stocks of urban vegetation will also provide the sequestration capability of the vegetation, which can be enhanced to offset the carbon emissions resulting from the human activities in the city. Enhancing the urban sinks will make these urban areas if not completely carbon neutral but surely a huge proportion of carbon emissions will be abated. Total tree biomass estimation of tree species using nondestructive method in Study area Globally and locally multiple satellite data has been used to study the forest cover, vegetation cover in urban areas. The overall goal of study is not only to estimate the urban green cover but to also to spread the awareness via publications and reporting on how each citizen can contribute towards offsetting the carbon emissions of their own cities by increasing the green cover.

Trees can contribute to the increase of local food and nutrition security, providing food such as fruits, nuts and leaves for both human consumption and fodder. Trees play an important role in increasing urban biodiversity, providing plants and animals with a favourable habitat, food and protection. A mature tree can absorb up to 150 kg of CO_2 per year. As a result, trees play an important role in climate change mitigation. Especially in cities with high levels of pollution, trees can improve air quality, making cities healthier places to live in. Trees also help to reduce carbon emissions by helping to conserve energy. Planning urban landscapes with trees can increase property value, by up to20percent, and attract tourism and business. As we have reviewed in this work, vegetation in cities can play an important role in: the aesthetics and design of cities; biological conservation; reduction intheuse of fossil fuels; and reduction in some forms of pollutants. This information can further be utilized to assess the impacts of vegetation health on the physical and mental health of the humans living in the study area.

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