Foliage for the Future: Using Urban Reforestation to Sequester Carbon

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Abstract

At the start of the 21st century, it was estimated that 50% of the Earth's population lived in urban cities (Zipperer, Northrop & Andreu, 2020). As populations continue to surge in cities, it is evident that a problem has emerged. Forests are being destroyed for urban expansion. Each year, over 32 million acres of forested land are destroyed to be developed into urban areas (Zipperer, Northrop & Andreu, 2020), which can have significant negative impacts on the climate crisis, specifically regarding its effects on carbon in the atmosphere. Trees and plants are able to sequester carbon through the process of photosynthesis, and when forested areas are destroyed, the process of photosynthesis cannot be performed (Reforestation, n.d.). One way this can be combated is by replenishing vegetation in deforested areas. Research was gathered on this topic by synthesizing original research experiments and analyzing literature. As a result, it was concluded that reforestation is one of the best methods of sequestering carbon.

Introduction

Climate change is becoming one of the most preeminent challenges of the 21st century. Since 1880, the global temperature of Earth has, on average, risen 0.04º F each decade (Lindsey & Dahlman, 2023). The effects Earth has endured due to this are severe. Extreme weather events have become more intense, ice caps have melted, and sea levels have risen (Lindsey & Dahlman, 2023). These effects have been amplified by the emission of greenhouse gases. Greenhouse gases, such as carbon dioxide and methane, stay in the atmosphere and trap heat, causing the overall temperature of the Earth to increase. To combat this, many efforts have been made to sequester greenhouse gasses, utilizing a multitude of different methods. One of which is reforestation, otherwise known as the process of replanting trees and plants. In this paper, it will be argued that reforestation is one of the best methods of sequestering carbon.

Reforestation's Advantages

Using reforestation as a technique of sequestering carbon has many considerable benefits. Trees are naturally effective carbon sinks, as one unit area of vegetation can, on average, sequester 7.69 kg/m^2 (Lind, et al. 2023), mostly through the process of photosynthesis. Plants photosynthesize by drawing carbon dioxide out of the air through the stomata and converting it into oxygen, which is then released into the atmosphere (Lambers, 2023).

Integrating vegetation into urban spaces would help sequester carbon not only by photosynthesis but also by decreasing the amount of energy expended by cities and buildings due to plants' cooling effects. An increase in canopy cover from trees provides shade and therefore cools the area in which it covers.

Secondly, the process of evapotranspiration cools the air surrounding trees (Rahman et al., 2020). Evapotranspiration is the process in which water is transferred from a plant to the atmosphere via the stomata of the plant, which can directly lower the surrounding air temperature between 1ºC and 8ºC (Rahman et al., 2020). Furthermore, this cooling property of plants is especially effective when in the proximity of buildings. Buildings would expend less energy to cool themselves and burn less fossil fuels, therefore emitting less carbon (Sayedabadi et al., 2021).

Additionally, urban forestation is space-effective. In the context of urban areas, vegetation would be able to be planted on roofs, as there are over 380 billion square meters of urban roof space (Getter, et al., 2009). Thus, in theory, reforestation in urban areas is feasible due to ample space to implement urban vegetation projects. In a 2017 study done by Har'el Agra et al., it was found that plants such as sedum and succulents would be most effective in spacial and energy efficiency because not only do they efficiently sequester carbon, but they also are lightweight, water efficient, and less susceptible to extreme weather conditions, making them especially suitable to be used on urban green roofs.

In summary, it can be said that reforestation has several advantages that make it one of the best methods of carbon sequestration. Reintegrating vegetation into urban spaces would not only remove carbon from the atmosphere through photosynthesis but would also decrease air temperatures, further slowing fossil fuel emissions. It is also space-effective, and if properly implemented, can be resistant to extreme weather conditions.

Application

Further adding to the appeal of using vegetation to sequester carbon is its practical application. For example, numerous cities globally have already implemented urban forests in their most populous metropolitan areas. Austin, Texas–one of the United States' largest cities–is home to over 33 million trees, covering about 18% of the city's total surface area (Steffan, 2021). This has been successful at sequestering carbon, as Austin has the third lowest carbon footprint of all major cities in the United States (Caleri, 2022).

Additionally, the application of sequestering carbon via urban forests has been proven successful. A 2002 study conducted by David J. Nowak and Daniel E. Crane states that in the United States, urban forests are responsible for currently storing 700 million tons of carbon. This number is significant because it is estimated that in order to fully counteract the effects of climate change caused by CO_2 emissions, 2 billion tons of carbon would need to be removed from the atmosphere (Moseman, 2023), therefore the 700 million tons of carbon stored in urban forests is substantial, as it is almost half of what is needed to reverse climate change.

Furthermore, the application of using reforestation to sequester carbon has had significant economic benefits. It should be noted that companies can also use reforestation as a method to lower their carbon emissions. Here, the carbon market is introduced. Carbon markets are economic systems in which companies offset their carbon emissions by purchasing carbon credits (What are carbon markets?, 2022). One way companies are able to offset their emissions is by buying credits in forestry and conservation, or in other words, reforestation and prevention of deforestation. This is often chosen as an offset technique, partially because it is an efficient method of removing carbon from the atmosphere and because it adheres to corporate social responsibility trends (Boulter, 2024). When companies help reforestation projects, they are not only offsetting their carbon emissions, but they are also contributing to the conservation of ecosystems and biodiversity, further incentivizing reforestation projects and sustainability goals.

Discussion

As discussed, there are many significant benefits to using reforestation to sequester carbon, such as its spatial effectiveness and efficiency in photosynthesis and evapotranspiration. Although, there are downsides that need to be considered. For example, if not researched properly, reforestation projects can fail. If the types of vegetation planted are not a good fit for the climate of the area, then the plants could cease photosynthesis, thus being a waste of time and resources. Likewise, there are species of plants that are dormant during certain seasons, and therefore would only be alive and able to photosynthesize for a portion of the year. While these are considerable drawbacks, they are manageable or avoidable. With proper research and understanding of how plants interact with climates, reforestation has the potential to be one of the best options to effectively sequester carbon.

A potential way in which more of these projects can be more widely funded is with help from the government. State governments already fund many public park and garden projects for local communities. For example, in 2020, the Great American Outdoors Act was signed into law, providing $900 million in funding to the United States Land and Water Conservation Fund (*Federal Funding*, n.d.).With more efforts such as these, the tree population can skyrocket. This would be just one important step in a larger journey. With proper conservation and reforestation efforts, the effects vegetation can have on carbon and more broadly, the climate, has the potential to be a major contribution to maintaining a healthy Earth.

Conclusion

Through extensive research and synthesis of the literature, it can be concluded that reforestation as a technique of sequestering carbon has many significant benefits and has been proven effective when it is implemented in urban settings. With global temperatures rising due to fossil fuel emissions and urban areas increasing, the need for more vegetation has become dire. For a more sustainable future, reforestation projects and urban forests need to be implemented as much as possible to maximize tree cover. If deforestation continues at its current rate, the effects of climate change will become more rampant. Action needs to be taken to begin fixing the negative effects of urban expansion. With more attention to reforestation and urban forestry, significant change can be made, ultimately leading to a healthier, more sustainable future.

References

Berkhout, J. A. A., & Van Keulen, H. (1986). Potential evapotranspiration. In *Modelling of agricultural production: weather, soils and crops* (pp. 63-75). Pudoc.

Boulter, J. (2024, January 5). *4 types of carbon offset projects*. EIC Partnership. https://eic.co.uk/4-types-of-carbon-offset-projects/

Caleri, B. (2022, August 11). *Houston steps to top of list of US cities with lowest carbon footprints*. https://abc13.com/houston-lowest-carbon-footprints-us-cities-austin/12117476/

Coppolino, J. (2019, August 10). *How planting trees can reduce your carbon footprint*. OneTreePlanted. https://onetreeplanted.org/blogs/stories/planting-trees-reduce-carbon-footprint

Federal funding for city parks. (n.d.). City Parks Alliance. https://cityparksalliance.org/federal-funding-city-parks/

Getter, K. L., Rowe, D. B., Robertson, G. P., Cregg, B. M., & Andresen, J. A. (2009). Carbon sequestration potential of extensive green roofs. *Environmental science & technology*, *43*(19), 7564-7570

Klein, T., Vasl, A., Kadas, G., & Blaustein, L. (2017). Measuring the effect of plant-community composition on carbon fixation on green roofs. *Urban Forestry & Urban Greening*, *24*, 1-4.

Lambers, H. and Bassham, . James Alan (2023, December 20). *photosynthesis*. *Encyclopedia Britannica*. https://www.britannica.com/science/photosynthesis

Lind E, Prade T, Sjöman Deak J, Levinsson A and Sjöman H (2023) How green is an urban tree? The impact of species selection in reducing the carbon footprint of park trees in Swedish cities. *Front. Sustain. Cities* 5:1182408. doi: 10.3389/frsc.2023.1182408

Nowak, D. J., & Crane, D. E. (2002). Carbon storage and sequestration by urban trees in the USA. *Environmental pollution*, *116*(3), 381-389.

Rahman, M. A., Stratopoulos, L. M., Moser-Reischl, A., Zölch, T., Häberle, K. H., Rötzer, T., ... & Pauleit, S. (2020). Traits of trees for cooling urban heat islands: A meta-analysis. *Building and Environment*, *170*, 106606.

Reforestation. (n.d.). U.S. Department of Agriculture. https://www.fs.usda.gov/managing-land/forest-management/vegetation-management/reforestation

Seyedabadi, M. R., Eicker, U., & Karimi, S. (2021). Plant selection for green roofs and their impact on carbon sequestration and the building carbon footprint. *Environmental Challenges*, *4*, 100119.

Steffan, L. (2021, September 11). *The most impressive urban forests around the world*. Intelligent Living. https://www.intelligentliving.co/most-impressive-urban-forests-around-the-world/

What are carbon markets and why are they important? (2022, May 18). Climate Promise. https://climatepromise.undp.org/news-and-stories/what-are-carbon-markets-and-why-are-they-important

Zipperer, Wayne C.; Northrop, Robert; Andreu, Michael. 2020. Urban development and environmental degradation. Oxford Research Encyclopedia of Environmental Science. Retrieved 01 Sep. 2020. https://oxfordre.com/environmentalscience/view/10.1093/acrefore/9780199389414.001.0001/acrefore-9780199389414-e-97

Lindsey, R., & Dahlman, L. (2023, January 18). *Climate change: Global temperature*. Climate.gov. https://www.climate.gov/news-features/understanding-climate/climate-change-global-temperature

Huo, D., Huang, X., Dou, X. *et al.* Carbon Monitor Cities near-real-time daily estimates of CO2 emissions from 1500 cities worldwide. *Sci Data* 9, 533 (2022). https://doi.org/10.1038/s41597-022-01657-z

Moseman, A., & Harvey, C. (2023, October 23). *How much carbon dioxide would we* *have to remove from the air to counteract climate change?* Climate Portal.

https://climate.mit.edu/ask-mit/

how-much-carbon-dioxide-would-we-have-remove-air-counteract-climate-change#:~:tex

t=To%20get%20the%20atmosphere%20back,according%20to%20one%20recent%20study.