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Rapid Communication

Carbon Sequestration: A Key Strategy in Combating Climate Change

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INTRODUCTION

The mounting threat of climate change has brought the concept of carbon sequestration into the spotlight. As global temperatures continue to rise and the concentration of greenhouse gases, particularly carbon dioxide (CO2), reaches unprecedented levels, scientists, governments, and industries are exploring solutions to mitigate the effects of climate change. Carbon sequestration, the process of capturing and storing atmospheric CO2, offers a promising avenue for reducing the amount of carbon in the atmosphere, helping to stabilize global climate patterns (Acemoglu.,et al 2003).

At its core, carbon sequestration involves capturing carbon dioxide and storing it in such a way that it does not enter the atmosphere. This process can occur naturally, through biological processes, or artificially, via technological interventions. The primary goal is to reduce the amount of CO2 in the atmosphere, thus slowing the pace of climate change and reducing its potentially devastating impacts. Natural carbon sequestration occurs through biological and geological processes. **Forests, soil, and oceans** are the most significant natural carbon sinks. Forests, especially tropical rainforests, play a crucial role in absorbing CO2 through photosynthesis. Trees and plants take in CO2, storing it in their biomass (trunks, roots, leaves) and releasing oxygen into the atmosphere. This process, known as biological carbon sequestration, has been ongoing for millions of years and remains a critical part of Earth's carbon cycle (Dexter.,et al 1987).

Soils also act as a carbon sink, storing vast amounts of carbon as organic matter. Practices such as reforestation, afforestation, and conservation agriculture can enhance soil's ability to sequester carbon. In agriculture, techniques like no-till farming, crop rotation, and the use of cover crops can increase the carbon content of the soil, making it a more effective carbon sink.**Oceans** are another significant natural carbon sink, absorbing nearly 25% of the CO2 released into the atmosphere each year. Marine plants like phytoplankton absorb CO2 during photosynthesis, and carbon is also stored in marine sediments. However, the increasing absorption of CO2 by oceans is causing ocean acidification, which negatively impacts marine ecosystems (Forde.,et al 2001).

Artificial, or **technological carbon sequestration**, involves capturing CO2 from industrial processes and storing it in geological formations, such as depleted oil and gas fields or deep saline aquifers. This process, known as **Carbon Capture and Storage (CCS)**, has been developed to capture CO2 before it is released into the atmosphere, particularly from power plants, cement factories, and other industries that emit large amounts of CO2.CCS involves three main steps: **capturing** the CO2 from the source, **transporting** it to a storage site, and **injecting** it deep underground into a geological formation. One of the key advantages of CCS is that it allows continued use of fossil fuels for energy generation while mitigating the environmental impact of CO2 emissions (Gregory.,et al 2009).

A related technology is **Carbon Capture, Utilization, and Storage (CCUS)**, where captured CO2 is repurposed for commercial uses, such as in the production of chemicals, building materials, or even carbonated beverages. This approach not only prevents CO2 from entering the atmosphere but also gives it economic value, potentially incentivizing its capture (Hetrick.,et al 1991).

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Carbon sequestration is a vital component of strategies aimed at reducing global greenhouse gas emissions. The **Intergovernmental Panel on Climate Change (IPCC)** has highlighted that in order to limit global warming to 1.5°C above pre-industrial levels, the world must drastically reduce its CO2 emissions. However, even with significant reductions, some level of carbon sequestration will be necessary to offset residual emissions and achieve net-zero goals (Hooper.,et al 1973).

Natural carbon sinks like forests and oceans are already absorbing a significant amount of CO2, but their capacity is limited, and many are under threat due to deforestation, land degradation, and ocean acidification. Therefore, enhancing these natural processes through reforestation, conservation, and sustainable land management practices is critical to maintaining and improving their carbon sequestration potential.On the technological side, **CCS** and **CCUS** have the potential to significantly reduce emissions from industries that are hard to decarbonize, such as cement, steel, and petrochemicals. However, these technologies face challenges related to cost, scalability, and public acceptance. Developing effective policies, infrastructure, and financial incentives will be necessary to make CCS and CCUS viable on a large scale (Janzen.,et al 1989).

The technology for capturing and storing carbon is expensive. CCS, in particular, requires significant infrastructure investments, and the process of capturing CO2 from industrial emissions can be energy-intensive, increasing overall costs.Natural carbon sinks, like forests and soils, have limits to how much carbon they can absorb. Similarly, the capacity of geological storage sites for CCS is finite, and identifying suitable and safe locations for long-term storage is critical (Rewald.,et al 2011).

In CCS, stored carbon can potentially leak from geological formations, negating the benefits of sequestration. Careful monitoring and regulation are necessary to ensure that stored carbon remains trapped over the long term (Scheres.,et al 2002).

Large-scale afforestation or reforestation projects can lead to the displacement of communities, loss of biodiversity, or other unintended ecological consequences. Similarly, the public may have concerns about the safety and environmental impacts of injecting CO2 underground for CCS.Many carbon sequestration projects take time to yield significant results. For instance, reforestation projects can take decades to absorb substantial amounts of CO2, meaning immediate emissions reductions are still crucial (Su.,et al 2017).

CONCLUSION

Carbon sequestration offers a critical pathway to mitigating climate change, complementing efforts to reduce emissions and transition to renewable energy sources. Whether through enhancing natural carbon sinks like forests and soils or developing technological solutions like CCS, the potential to capture and store carbon is an essential part of the global climate strategy.However, while carbon sequestration is promising, it is not a silver bullet. It must be part of a broader mix of solutions, including reducing fossil fuel consumption, increasing energy efficiency, and promoting renewable energy. Only by addressing both the causes and consequences of climate change can we hope to avert its most catastrophic impacts and ensure a sustainable future for generations to come.

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