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Preserving waterbodies, safeguarding the future: carbon sequestration and climate change intervention of india

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ABSTRACT:
The important role that wetlands play in carbon sequestration and mitigating climate change in India is examined in the paper. Wetlands are essential natural allies in lowering atmospheric CO_2 levels because of their remarkable capacity to store carbon, which is particularly noteworthy in light of the growing need to address climate change. This study showcases India's rich and varied wetland habitats, which include coastal mangroves, floodplain wetlands, and high-altitude Himalayan lakes. It draws attention to the difficulties brought forth by climate change and human activity, which make proactive restoration efforts necessary to preserve these ecosystems. In order to show how well created wetlands might increase carbon retention, the report also compares the sequestration of carbon in natural and artificial wetlands in Botswana, Costa Rica, and Ohio. The study advocates for integrating wetland restoration into climate policies, optimizing restoration practices, and leveraging the potential of both natural and artificial wetlands to combat global warming. By preserving these ecosystems, the paper argues, India can significantly contribute to global climate changeintervention efforts, ensuring the long-term sustainability of its vital waterbodies.

Keywords: Carbon Sequestration, Wetlands, Climate Change Mitigation, Ecosystem Restoration, Blue Carbon Sinks, Biodiversity

INTRODUCTION:

Carbon diffusion strategies are becoming increasingly important as the pressure to counteract climate change increases. Climate change and the prevalence of greenhouse gases in the atmosphere are pressing concerns that require decisive change in order to protect the habitats of the Earth. Because of their remarkable capacity to store carbon, wetlands stand out as one of the most important and practical natural ways to lower CO_2 levels in the atmosphere. The wetland of India is distinguished by a vast array of topographical features, including a long coastline, subterranean and surface geological formations, diverse forest kinds, and different land cover systems. It also has a highly diversified climate. Wetland ecosystems are created as a result of interactions between various natural areas. The high-altitude Himalayan lakes are the most notable examples of natural wetlands in India. Other examples include wetlands found in the flood plains of the country's major river systems, saline and transient wetlands found in arid and semi-arid regions, coastal wetlands like lagoons, backwaters, and estuaries, mangrove swamps, coral reefs, and marine wetlands, among others. Earth's ecosystems are deteriorating due to human activities like infrastructure development and agriculture, as well as the negative effects of climate change. The restoration of these environments frequently requires human intervention because they are not able to do so on their own. There are a number of obstacles that come with habitat restoration programs, including social opposition and financial rivalry. For this reason, the initiative "Preserving Waterbodies, Safeguarding theFuture" is significant in ensuring the protection of vital ecosystems like wetlands, which play a crucial role in carbon sequestration and climate change mitigation.

India's tropical wetlands provide a diverse array of upland, coastal, and marine environments.Wetlands are among the most productive life supports and are very important from an ecological and socioeconomic standpoint. For natural biodiversity to survive, they are essential. Wetland ecosystems are abundant in India and are dispersed throughout the country's many regions. The majority of India's wetlands are connected to significant river systems, including the Ganges, Cauvery, Krishna, Godavari, and Tapti, either directly or indirectly. These ecosystems provide a diverse range of ecosystem goods and services, are frequently quite productive, and are home to a distinctive collection of aquatic and terrestrial species (Wetlands Rules, 2010). Wetlands offer a variety of benefits, such as irrigation, recreational water, freshwater fishing, and residential water supplies. Additionally, they are crucial to flood management, pollution reduction, carbon sequestration, and groundwater recharge. But more quickly than any other form of habitat in the world, inland and coastal wetlands are disappearing and becoming less healthy. The degradation will worsen due to climate change, and this tendency will significantly intensify in the upcoming years.

This paper discusses carbon dioxide, its capture, and its storage by restoring habitats that sequester CO_2. Three habitats are highlighted: oceans, wetlands, and forests. Both wetlands and oceans are referred to as blue carbon sinks, meaning that carbon is stored via water within these ecosystems [1]. Wetlands offer many ecosystem services to humankind, including water quality improvement, flood mitigation, coastal protection, and wildlife protection.

A CASE STUDY: USE OF WETLAND:

The study looked at carbon sequestration in wetlands that were built and naturally occurring in Botswana, Costa Rica, and Ohio. Using gamma spectrometry, soil cores were removed and examined to ascertain soil accretion rates. Particular attention was paid to the activity of isotopes such as 210Pb and 137Cs [2]. Carbon sequestration in natural wetlands was determined by measuring the carbon content of the soil down to the depth indicated by the 1964 137Cs peak. To take wetland heterogeneity into consideration, many cores were composited. Sediment depth and carbon content were recorded over time at several grid sitesin Ohio's artificial wetlands in order to determine carbon sequestration. The mean carbon sequestration in the various plant communities inside the wetlands was estimated using the data.

In our study of seven wetlands, four of the five most effective in net carbon retention were located in the temperate zone. The two constructed freshwater marshes in Ohio and the flow- through tropical slough in Costa Rica stood out for their high net carbon retention. These created wetlands in Ohio sequestered more carbon and emitted less methane compared to the reference wetland at Old Woman Creek. Similarly, the tropical slough in Costa Rica, with its comparable geomorphology and hydrology, demonstrated high net carbon retention, likely due to its flow-through conditions optimizing carbon sequestration while minimizing methane emissions. Similar approaches could greatly improve carbon sequestration in India's varied wetland ecosystems, especially in areas where hydrology and climate conditions allow for the best possible carbon retention and the least amount of methane emissions. This would aid in the country's efforts to mitigate climate change.

Additionally, from 14 other studies reviewed, the most effective wetlands for carbon retention were found in Europe. These included a former farmed peatland in the Netherlands and a Phragmites marsh in Denmark. The Dutch peatland, once an abandoned meadow, had been restored as a wetland nature reserve 10 years before the study by Hendriks et al. (2007) [3].
Due to its relatively low methane emissions (31 g-C m-2 year-1) and high productivity (gross primary productivity = 1,177 g-C m-2 year-1), this site achieved a CO_2 sequestered to CH_4 emission ratio of 27.4:1 initially, increasing to 249:1 after 100 years.

STRATEGIES FOR MITIGATION OF CLIMATE CHANGE THROUGH CARBON SEQUESTRATION:

There are primarily two ways to lessen the amount of global warming brought on by greenhouse gases: lowering or eliminating emissions from various sources, or increasing the removal of carbon from the atmosphere. It is quite difficult, but according to governments around the world, non-governmental organizations, and scientific communities, the average yearly global temperature shouldn't rise by more than 2 °C over pre-industrial levels. In orderto do this, global greenhouse gas emissions must be lowered to almost zero by the end of thiscentury and by 40–70% by the middle of the century as compared to 2010 levels. One of the key tactics to reduce the amount of CO_2 in the atmosphere is to capture and store atmosphericcarbon for an extended period of time using artificial or natural methods. [4]

NATURAL AND ARTIFICAL WETLANDS:

Because they serve as long-term carbon sinks and promote biodiversity, water quality, and flood protection, natural wetlands are essential for lowering carbon emissions and restoringecosystems. In regions where natural wetlands have disappeared, artificial wetlands that areintended to mimic these processes can improve carbon sequestration and lessen climate change, thus promoting environmental sustainability. The overall goal of reducing carbon emissions is strengthened when both kinds of wetlands are included in climate policies.

Level-I	Level-II Code	Level-III Code
Inland Wetlands	Natural (1100)	**1101:** Lakes
		1102: Ox-Bow Lakes/Cut-off Meanders
		1103: High altitude Wetlands
		1104: Riverine Wetlands
		1105: Waterlogged (natural)
		1106: River/Stream
	Man-made (1200)	**1201:** Reservoirs/Barrages
		1202: Tanks/Ponds
		1203: Waterlogged (man-made)
		1204: Salt Pans (inland)
		1205: Aquaculture ponds (inland)
Coastal Wetlands	Natural (2100)	**2101:** Lagoons/Backwaters
		2102: Creek
		2103: Sand/Beach
		2104: Intertidal mud flats
		2105: Salt marsh
		2106: Mangroves
		2107: Coral Reefs
	Man-made (2200)	**2201:** Salt Pans (Coastal)
		2202: Aquaculture ponds (coastal)

Table 1: Classification of India's Wetlands System [*Source: Wetland ClassificationSystem (Ref: Garg J.K. and Patel J. G., 2007)]*

Artificial wetlands play a key role in combating global warming by sequestering atmospheric CO_2 and enhancing biodiversity. They mimic natural wetlands, efficiently capturing carbon, supporting diverse species, and improving water quality and flood control. To maximize thesebenefits, it is crucial to optimize restoration practices, including selecting appropriate plant species, designing for optimal water flow, and managing invasive species. Future research should focus on understanding the complex interactions within these ecosystems to further improve their design and management.

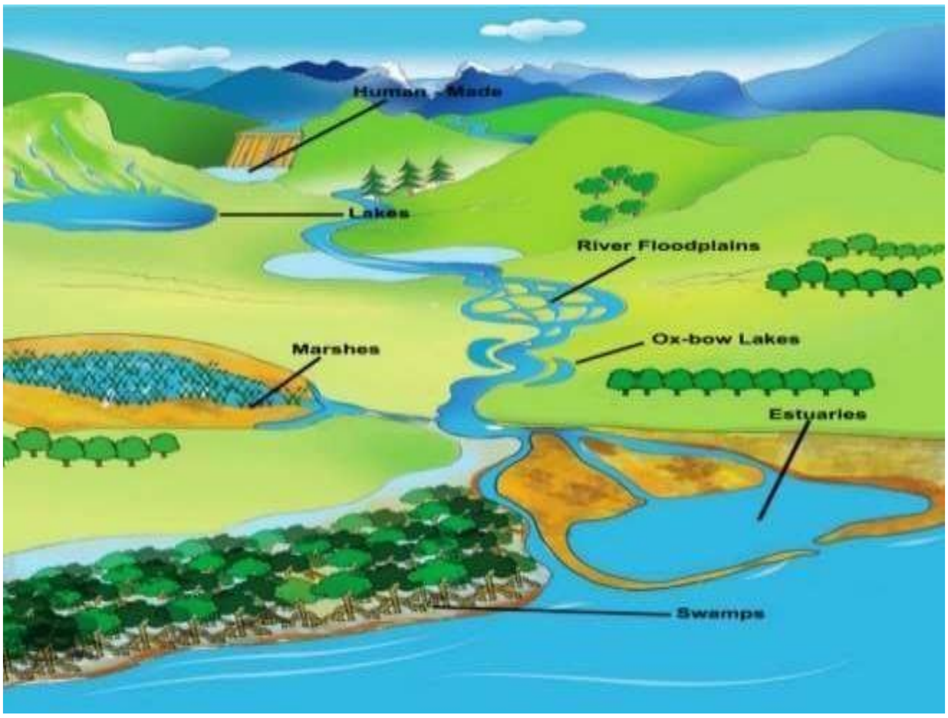

Figure 1: Wetland Types (*Source: https://indianwetlands.in/wetlands-overview/wetland-types/*)

The section classifies several kinds of wetlands and bodies of water, explaining their traits andappearances in satellite photos. These comprise lakes, oxbow lakes, riverine wetlands, high- altitude wetlands, and naturally and artificially flooded places. It also covers coastal characteristics including salt marshes, mangroves, and coral reefs, as well as tanks, lagoons, creeks, and aquaculture ponds [5]. The explanations highlight the distinctive characteristics, hues, and forms of these wetlands and bodies of water, emphasizing their ecological significance and how to recognize them in satellite imagery.

<u>REFORESTATION FOR CARBON SEQUESTRATION</u>:

Like other habitats, forests release CO_2 when they burn or decompose. Considering the large amounts of forest cut down every year, for purposes such as agriculture or manufacturing, restoration becomes a more urgent issue each day.

In the United States, around 33 millions hectares of forestland are classified as non-stocked or poorly stocked. This is because only around 1% of understocked timberland is restored every year, and current rates of tree-planting only contribute about 3 to 5% to carbon sequestration from trees. However, if all understocked forestland were to be restored, there is potential to raise the country's forests' carbon sequestration capacity to 20% [6]. Challenges arise for reforestation due to a multitude of reasons. Oftentimes, the issue of forest restoration holds social and economic competition with other objectives in land use and management.

Additionally, degraded forests generally do not sufficiently restore naturally because they are more susceptible to wildfire and often have poor seed banks due to practices such as logging and agriculture. Nonetheless, efforts to restore forestland have proven to be successful. One such example of restoration follows a study conducted within forestland in Kibale National Park, Uganda [7]. Parts of this park were deforested as a result of agriculture and the removalof timber for fuel wood. Natural regeneration of the forest was strongly inhibited due to the growth and domination of elephant grass. The process of restoration included protection fromfire as well as the planting of 400 native seedlings per hectare of forestland. 3,241 hectares were planted in total; about 47,700 megagrams of carbon were sequestered at the end of 18 years. Estimates report that if 10,000 hectares were to be restored, roughly 2 teragrams of carbon would be sequestered [7].

The adaptation planning process for wetlands involves a comprehensive approach that starts with identifying key wetland areas through detailed assessments. This process ensures that the most critical wetlands are recognized for their ecological value and vulnerability. Following identification, adaptation strategies range from enhancing natural resilience to implementing targeted conservation measures. Financial support plays a crucial role in this process, providing the necessary resources to effectively manage and conserve wetlands. According to Carew-Reid et al. in "Managing Climate Risks in Wetlands: A Practitioner's Guide," [8] a well-structured adaptation plan integrates these elements to safeguard wetland ecosystems against climate change impacts and ensure their long-term sustainability.

Figure 2: Adaptation Planning Process

CONCLUSION:

India's attempts to maintain ecological sustainability and prevent climate change heavily depend on the preservation and restoration of wetlands. Wetlands provide crucial ecosystem services like flood management, water purification, and biodiversity support in addition to acting as key carbon sinks and a naturally occurring way to lower atmospheric CO2 levels. The case studies examined in this paper demonstrate the potential of artificial and natural wetlands to improve carbon sequestration; notable results have been shown in a range of climatic and geographic circumstances. India can maximize the amount of carbon that its wetlands can retain by using strategic restoration measures, such as managing the hydrological conditions and carefully selecting the plant species.

Integrating wetlands into climate policies is crucial for maximizing their environmental benefits. As this paper illustrates, restoring degraded wetlands and promoting artificial wetlands in areas where natural ones have disappeared can significantly bolster carbon sequestration efforts. However, challenges such as social opposition, financial competition, and ecological complexities must be addressed through comprehensive adaptation planning and collaborative efforts among governments, NGOs, and local communities. By safeguarding these critical ecosystems, India not only contributes to global climate change mitigation but also enhances its natural heritage and environmental resilience. This approach paves the way for a sustainable future where wetlands continue to thrive and provide invaluable benefits to both people and the planet.

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