Research Published By: Georgia Institute of Technology

Excess greenhouse gasses in the atmosphere, such as carbon dioxide, are one of the key drivers of climate change. Mitigating climate change in the future century will necessitate both de-carbonization (electrifying the power grid or lowering fossil fuel-guzzling transportation) and carbon dioxide removal (removing existing carbon dioxide from the atmosphere).

Georgia Institute of Technology and Yale University researchers have proposed a novel approach for coastal ecosystem restoration that can permanently capture carbon dioxide from the atmosphere. Blue carbon ecosystems, such as seagrass and mangroves, naturally capture carbon through photosynthesis, which turns carbon dioxide into living tissue.

"Mangroves and seagrasses extract carbon dioxide from the atmosphere all day long and turn it into biomass," said Chris Reinhard, an associate professor at the School of Earth and Atmospheric Sciences (EAS). "Some of this biomass may become buried in sediments, and if it does, you've effectively removed carbon dioxide from the atmosphere."

Restoring these habitats could benefit local flora and wildlife while also reviving coastal businesses. However, Reinhard and colleagues now propose that restoring them could also remove extra carbon via a unique method while mitigating rising ocean acidity.

They published their findings in Nature Sustainability in May as "Ocean Alkalinity Enhancement Through Restoration of Blue Carbon Ecosystems."

Carbon 101

Organic carbon and inorganic carbon are the two principal forms of carbon that circulate through the Earth's system. Organic carbon is found in living things including algae, plants, animals, and even humans. This type of carbon can temporarily remove carbon dioxide from the atmosphere, but if it becomes buried in seafloor sediments, it can lead to permanent carbon dioxide removal. Inorganic carbon can be found in a variety of forms, including rocks and minerals, although it is primarily found as a dissolved component of ocean water. Approximately 30% of the carbon released by human activities since the industrial revolution is now deposited in the ocean as dissolved inorganic carbon. Although organic carbon storage can be disrupted, effectively dispersing carbon dioxide back into the atmosphere, inorganic carbon removal has the potential to be far more permanent.

"Even if you change the way a coastal ecosystem restoration project operates, potentially remobilizing previously stored organic carbon," said Mojtaba Fakhraee, main author of the study and former postdoctoral researcher in EAS. "Thus, even if a massive ecosystem disruption in the future undoes organic carbon storage, the captured inorganic carbon will remain in the ocean indefinitely."

Carbon Capture and Acidity Reduction

Natural coastal ecosystems take carbon from the atmosphere and provide a variety of environmental and economic advantages to coastal populations; yet, many human actions have resulted in substantial damage or destruction of natural coastal environments. Planting new mangroves and seagrasses, as well as preserving and conserving the whole ecosystem, can help to restore their function and remove additional carbon from the atmosphere. Reinvigorating coastal ecosystems as a method of reducing carbon emissions is not a novel concept, but previous research has concentrated on organic carbon burial rather than the possibility for carbon removal through the creation of inorganic carbon.

"The basic idea here is that you are shifting the ocean's acid-base balance to drive the conversion of carbon dioxide in the atmosphere to inorganic carbon in the ocean," Reinhard explained. "This means that the process can help to partially offset the negative ecological consequences of ocean acidification."

Carbon Capture Modeling

The researchers created a numerical model to represent the chemistry and physics of sedimentary systems -- the complex mixture of solid particles, living organisms, and seawater that accumulates at the seafloor -- to investigate how effective restoring coastal ecosystems could be for inorganic carbon capture. The model's significant innovation is that it specifically examines the potential benefits of restored mangrove or seagrass ecosystems and their effects on organic and inorganic carbon cycling. It also accounts for the effects of other greenhouse gasses, such as methane, which can be produced during the restoration of mangrove and seagrass ecosystems.

"Based on how much mangrove is growing above the sediment, this model generates representations for the rates of carbon transformation in the sediment," said Noah Planavsky, senior author of the paper and professor of Earth and planetary sciences at Yale. "We discovered that, across a wide range of scenarios, restoration of blue carbon ecosystems results in long-term carbon dioxide removal as dissolved inorganic carbon."

The researchers anticipate that their findings will give impetus to safeguard existing coastal ecosystems and monetarily stimulate restoration of degraded ecosystems, potentially as a novel kind of carbon offset.

"Companies attempting to offset their own emissions could potentially purchase carbon removal by funding coastal ecosystem restoration," Reinhard added. "This could help rebuild these ecosystems and all of the environmental benefits they provide, while also removing carbon dioxide from the atmosphere in the long run."
Source: www.sciencedaily.com