LAND CONSERVATION

Understanding Impacts of Sea Level Rise on Coastal Marshes Through Soil Carbon Dynamics in Louisiana

A Salt Marsh in Barataria Basin, Louisiana/Eric J. Ward/USGS

INTRODUCTION

Louisiana's marshes make up 40% of coastal wetlands in the United States, providing habitats, erosion control, water filtration, and a high potential for carbon sequestration. However, many coastal marshes face permanent submergence due to high rates of sea level rise (SLR).

When wetlands transition to open water, they lose their abilities to store large amounts of atmospheric carbon in their plants and soil. Researchers developed a new wetland soil carbon model to better understand the effects of SLR and coastal marsh loss on soil carbon storage, informing conservation and restoration efforts.

KEY ISSUES ADDRESSED

In the United States, coastal marshes store an average of 8.5-8.7 million tons of carbon dioxide equivalent per year in their soils. When coastal marshes transition to open water due to SLR, marsh vegetation dies out because it cannot survive complete submergence. This contributes to changes in marsh soil chemistry and microbiology, which may reduce the amount of carbon stored in these habitats.

Without models of the mechanisms controlling wetland soil carbon chemistry, it is difficult to accurately assess how coastal marsh loss affects carbon sequestration. Additionally, flooded marsh conditions create challenges for marsh monitoring and data collection. Researchers, land managers, and climate planners need more accurate data and models to assess the consequences of wetland loss and restoration.

PROJECT GOALS

- Develop a wetland soil carbon model
- Collect data to understand the baseline conditions and soil carbon dynamics involved in coastal marsh collapse
- Use data to calibrate the new model and test soil carbon assumptions
- Use findings to Inform carbon budget estimates and resource management

Project Location

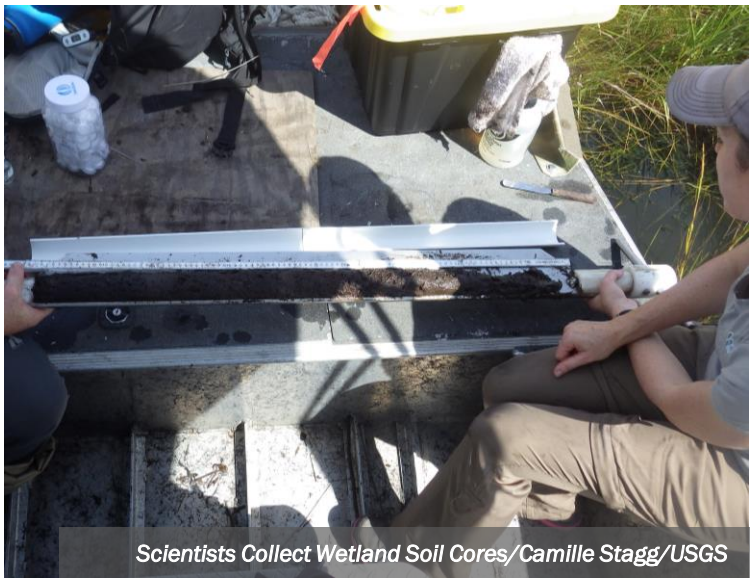
PROJECT HIGHLIGHTS

Develop a Wetland Soil Carbon Model: USGS researchers collaborated with scientists from Tulane University, The Water Institute of the Gulf, and Louisiana State University to understand how the loss of coastal marsh vegetation changes the soil microbial community. They incorporated findings into terrestrial soil carbon models to create a new wetland soil carbon model.

Collect Wetland Transition Data: Researchers identified coastal marsh sites at varying stages of submergence using remote-sensing and land change analysis. They measured soil strength and soil collapse at these sites to examine the process of wetland loss.

Test Model Assumptions: Researchers used marsh soil core samples to conduct incubation experiments measuring wetland loss impacts on greenhouse gas emissions and soil carbon degradability. Ongoing data collection is used to validate the new wetland soil carbon model.

Model Soil Carbon Loss: The new wetland soil carbon model shows that submerged wetlands lose 40% of stored soil carbon over approximately 200 years, a slower rate than assumed. Results also show how the loss of vegetation that accompanies wetland submergence removes the wetland's future carbon storage capacity.



Scientists Collect Wetland Soil Cores/Camille Stagg/USGS

LESSONS LEARNED

Quantifiable soil carbon measurements allow land managers and planners to utilize decision support tools. One such tool, the LUCAS model, shows changes in land use and ecosystem carbon storage and flux. Understanding direct impacts of wetland conservation and restoration efforts helps decision-makers confidently support related policies and plans.

Drawing on the innovations, data collection techniques, and study findings from terrestrial ecology enabled researchers to better understand the role of plants in wetland soil carbon dynamics. Wetland ecology is a relatively young field. This study's wetland soil carbon chemistry model was adapted from agricultural models, allowing researchers to apply existing knowledge to advance marsh studies.

The negative effects associated with SLR go beyond reduced carbon sequestration capacity. SLR also adversely impacts marsh vegetation and ecosystem services. This wide range of challenges creates an opportunity for researchers to communicate the holistic value of protecting coastal marsh habitats alongside findings about carbon storage and emissions reduction.

NEXT STEPS

- Apply the wetland soil carbon model to study other types of coastal marsh loss
- Improve greenhouse gas inventories
- Use the wetland soil carbon model to inform decision making and assess wetland conservation and restoration outcomes

PARTNERS

- See online for full list of partners
- For more information, contact Camille Stagg: staggc@usgs.gov

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CART Author: Jessica Zimmerman, January 2025.
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Read the full Case Study: