Everglades National Park

Mangrove Soil Carbon Capture

The unique value of mangrove soils

National Park Service
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Natural Resources Stewardship & Science
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*Everglades National Park
NPS Photo*

Mangroves in Everglades National Park

Everglades National Park (Figure 1) was designated in 1993 and is the only subtropical wilderness within the United States. The park covers over 1.5 million acres and protects a diverse range of species and ecosystems, including the largest expanse of mangrove forests in the Northern Hemisphere.

Mangroves grow along shorelines in salt and brackish water and are often recognized by their dense tangle of roots that make the trees appear to be standing above the water. Since mangroves are almost permanently waterlogged, they have adapted mechanisms to thrive in this challenging environment. Mangroves form aerial roots that obtain oxygen above ground because the soils below the water are severely anoxic (low oxygen). To cope with the salinity, mangroves not only exclude salt and have a high tissue salt tolerance, but actively secrete salt through glands on their leaves.

Mangroves have two vital roles in coastal systems. First, they aid in shoreline protection by trapping sediment to stabilize the shoreline, reducing erosion from waves and storms, and filtering sediments that protect offshore habitats such as coral reefs and seagrass. Second, the dense root systems provide habitat for a diverse community of fish, crab, shrimp, and mollusks.

Figure 1. Everglades National Park, Florida

Carbon Sequestration in Mangrove Soils

In addition to these valuable attributes, mangroves play an important role in reducing the amount of carbon in the atmosphere.

Like all plants, mangroves sequester (take up) carbon dioxide (CO_2) from the air during photosynthesis to build leaves, branches, trunks, and roots. Once a plant dies, it begins to decompose and it is the decomposition process that releases CO_2 back to the atmosphere. However, in mangrove systems the decomposition process is underwater and extraordinarily slow due to the anoxic conditions and very little CO_2 is released. The carbon sequestration continues to accumulate in the submerged soils as more leaves, branches, and other dead matter (detritus) fall into the water and are covered by sediment. Because mangroves lay at the interface between land and sea, daily tides move detritus and sediments into the tangled mangrove root system for continued accumulation at an average rate of 3.2 mm per year. The carbon-rich soils below the mangroves can remain locked beneath the surface for centuries or more if not disturbed. However, once mangrove soils are disturbed by human or natural causes, and exposed to oxygen, carbon is released back into the atmosphere as CO_2.

Everglades Mangrove SOC

A global mangrove study by Sanderman et. al. (2018) provided a way to estimate the amount of soil organic carbon (SOC) in parks. Essentially, their study delineated mangrove area for 2017 to estimate SOC per hectare using a machine-learning statistical model to map the vertical and horizontal variability in soil density. A hectare is about the size of two football fields. There are approximately 192,200 hectares of mangrove habitat distributed across Everglades National Park, which is nearly ⅓ of the park area. To calculate how much SOC is stored, the SOC values for mangrove habitat were summed for the entire park and it was determined that these mangroves harbor 101,450,000 metric tons of carbon (MT C). The amount of SOC stored varies across the park (Figure 2).

To relate how much carbon resides in the mangrove soils to carbon dioxide (CO_2), we used the EPA's Greenhouse Gas Equivalencies Calculator and found 101,450,000 MT C equals 372,000,000 MT CO_2.

Everglades mangrove SOC is equivilant to:

- The amount of CO_2 emitted from your car while driving to the moon and back 2 million times!
- 4.6 days worth of global CO_2 emissions.

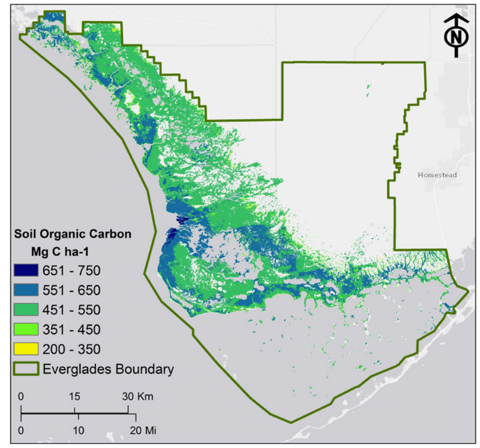

Figure 2. Soil organic carbon (SOC) is presented as megatons of carbon per hectare (Mg C ha1). Lighter colors represent lower amounts of SOC and darker colors represent higher amounts.

Dynamic Change & Mangroves

Future climate scenarios have a large degree of uncertainty, but all show that there will likely be changes in ocean circulation, sea surface temperature, salinity, pH, and sea level, all of which will have a strong impact on the ability of mangroves to survive. Even though mangroves are highly adapted to coastal processes, their ability to adapt to local conditions may not be fast enough to keep up with environmental changes. For example, sea level rise is estimated to be about 4 mm/year, and as waters become deeper, established mangroves could become too submerged and seedling establishment would slow. Likewise, the frequency and intensity of severe storms, such as hurricanes, could have several negative impacts including severe erosion, loss of foliage, or loss of entire tree stands. In some instances, there could be a positive impact of environmental change where more numerous ocean surges would increase sediment deposition and carbon accumulation.

When mangroves are disturbed, CO_2 is released and valuable habitat for a variety of species is lost. To this end, mangrove protection is a critical resource for climate change resilience and coastal health. The NPS is committed to long-term protection of these valuable resources.

More Information

Sanderman, J., T. Hengl, G. Fiske, K. Solvik, M. Fernanda Adame, L. Benson, J. J. Bukoski, P. Carnell, M. Cifuentes-Jara, D. Donato (2018) A global map of mangrove forest soil carbon at 30 m spatial resolution. Environmental Research Letters, 13, 5.

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