Coastal ecosystems are a net greenhouse gas sink, new research shows

May 23 2023

Fjords are coastal systems that act similar to the ocean. They take up large amounts of CO_2 from the atmosphere. Some fjords emit also N_2O and small amounts of CH_4. On balance, fjords are a greenhouse gas sink. Credit: Dong Zhang on Unsplash

A new greenhouse gas budget shows coastal ecosystems globally are a

net greenhouse gas sink for carbon dioxide (CO_2) but emissions of methane (CH_4) and nitrous oxide (N_2O) counteract some of the CO_2 uptake, according to international researchers led by Australia's Southern Cross University.

The new findings of the coastal greenhouse gas balance (CO_2 + CH_4 + N_2O) in 10 world regions and globally are outlined in the paper, "Coastal vegetation and estuaries collectively are a greenhouse gas sink," published May 22 in *Nature Climate Change*.

From tropical lagoons to polar fjords, from coastal mangrove forests to underwater seagrass communities, many coastlines around the world show high diversity in greenhouse gas sinks and emissions.

"Understanding how and where greenhouse gases are released and absorbed in coastal ecosystems is an important first step for implementing effective climate mitigation strategies," said lead researcher, Dr. Judith Rosentreter, Senior Research Fellow at Southern Cross University.

"For example, protecting and restoring mangrove and salt marsh habitats is a promising strategy to strengthen the CO_2 uptake by these coastal wetlands."

Other activities to curb human impact, like reducing nutrients, organic matter, and wastewater inputs into coastal waterways, can reduce the amount of CH_4 and N_2O released to the atmosphere.

The global team of scientists looked at ten different world regions: North America, South America, Europe, Africa, Russia, West Asia, South Asia, East Asia, Southeast Asia and Australasia (see Figure 1).

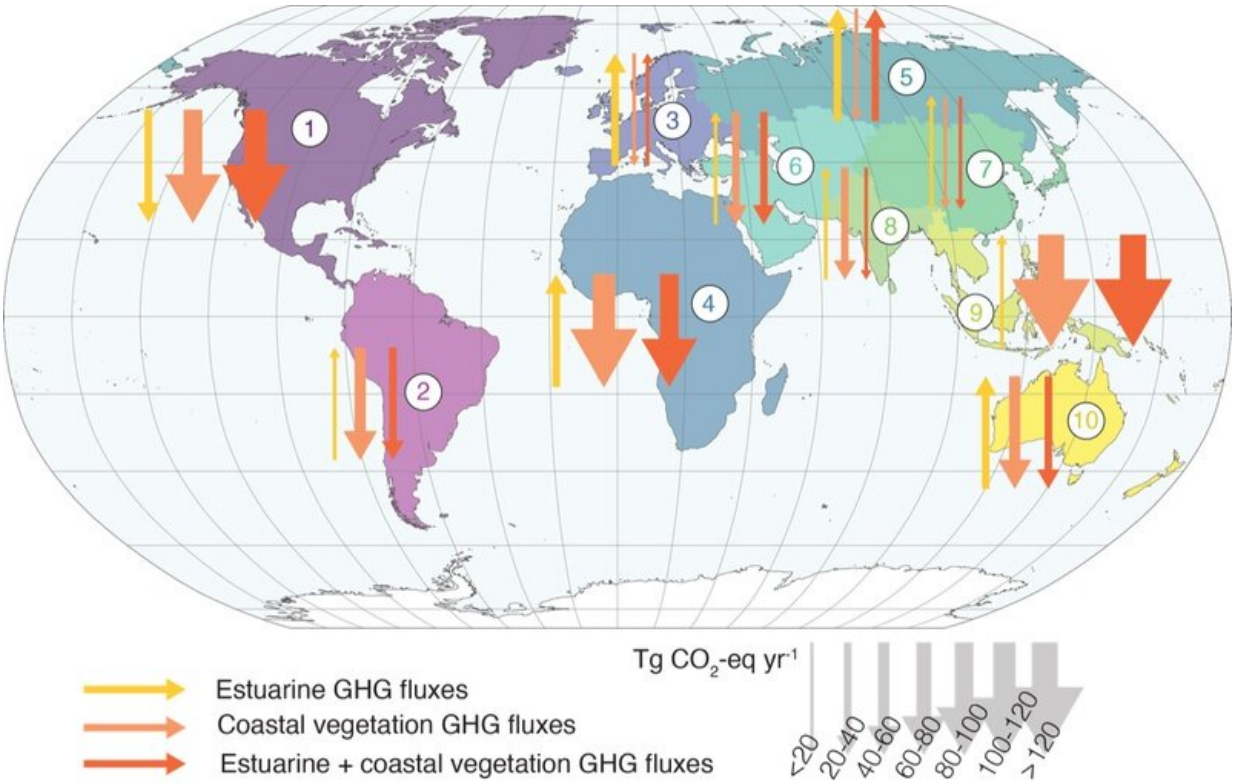

Figure 1: The coastal greenhouse gas (GHG) budget (CO_2 + CH_4 + N_2O) as CO_2-equivalent fluxes (in teragrams of CO_2-equivalent per year) in 10 regions around the world: Southeast Asia (9), North America (1), Africa (4) are strong coastal GHG sinks. South America (2), Australasia (10), and West Asia (6) are moderate coastal GHG sinks. East Asia (7) and South Asia (8) are weak coastal GHG sinks, and Europe (3) and Russia (5) are weak coastal GHG sources. Credit: *Nature Climate Change* (2023). DOI: 10.1038/s41558-023-01682-9

They found the strongest coastal greenhouse gas (GHG) sink was in Southeast Asia because of its extensive and productive tropical coastal wetlands that take up CO_2. A second sink hotspot is North America, with its large areas of coastal wetlands but also CO_2-uptaking fjords.

"Our new research shows that fjords around the world take up ~40% of CO_2 that would otherwise be released from tidal systems, deltas and

lagoons. Most (86%) of this important CO_2 uptake by fjords comes from the North America region, mostly Greenland," said co-author Professor Bradley Eyre, Professor of Biogeochemistry at Southern Cross University.

Dr. Rosentreter added, "Other coastal habitats are sources of greenhouse gases. For example, coastal wetlands such as mangrove forests, coastal salt marshes and seagrasses, release more than three-times more CH_4 than all estuaries in the world."

At the same time coastal wetlands, also called coastal "blue carbon" wetlands, can be strong sinks of CO_2 and some also take up N_2O, which, on balance, makes them a net GHG sink for the atmosphere when all three greenhouse gases are considered.

"In our new study, we show that when we consider all three greenhouse gases (CO_2 + CH_4 + N_2O), eight out of the 10 world regions are a coastal net greenhouse gas sink," Dr. Rosentreter said.

The findings will inform the efforts of the Global Carbon Project's RECCAP2.

"The research was initiated by the Global Carbon Project to establish greenhouse gas budgets of large regions covering the entire globe, and for which the contribution of these coastal ecosystems remained unaccounted for," said co-author Pierre Regnier, Professor of Earth System Science at Université Libre de Bruxelles.

Snapshot: Coastal greenhouse gas sinks and sources around the world

A dataset of observations from 738 sites from studies published between

1975 and 2020 was compiled to quantify CO_2, CH_4, and N_2O fluxes in estuaries and coastal vegetation in 10 global regions.

Special coastal features (climate, hydrology, abundance) in each region around the world drive the GHG uptake and/or release from coastal systems.

Strongest coastal greenhouse gas sinks:

- Top: the archipelagic region of Southeast Asia, because of its extensive and productive tropical mangrove forests and seagrasses that take up large amounts of CO_2.
- Next: North America because of its large areas of salt marshes, mangroves, and seagrasses but also CO_2-uptaking fjords.
- Third: Africa with large CO_2 uptake by mangroves and seagrasses that is moderately reduced by estuarine GHG emissions.

Moderate coastal greenhouse gas sinks:

- South America: moderate CO_2 uptake by coastal wetlands, especially mangroves, and some estuarine GHG emissions.
- Australasia: long stretches of coastal wetlands that take up CO_2, but this region also has a large number of estuaries along its coasts, many of which are a source of CO_2, CH_4 and N_2O.
- West Asia: weak estuarine GHG source and moderate CO_2 uptake by coastal wetlands, mostly seagrasses.

Weak coastal greenhouse gas sinks:

- East Asia and South Asia: the moderate coastal wetlands CO_2 sink is largely reduced by estuarine GHG emissions.

Weak coastal greenhouse gas sources:

- Europe and Russia: both regions release more coastal GHG than they can take up from the atmosphere. These regions have many impacted tidal estuaries that release greenhouse gases; a colder climate also means they have fewer coastal wetlands (e.g., mangroves) that would otherwise take up large amounts of CO_2.

More information: Judith A. Rosentreter et al, Coastal vegetation and estuaries are collectively a greenhouse gas sink, *Nature Climate Change* (2023). DOI: 10.1038/s41558-023-01682-9

Provided by Southern Cross University