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Alaskan carbon assessment has implications for national climate policy

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Left: Crumbling blocks of permafrost along the Beaufort Coast, Alaska (Photo courtesy of USGS). Right: Methane bubbles trapped in thermokarst lake ice. When ice-rich permafrost thaws, former tundra and forest turns into a thermokarst lake as the ground subsides. The carbon stored in the formerly frozen ground is consumed by the microbial community, which release methane gas. When lake ice forms in the winter, methane gas bubbles are trapped in the ice (Photo courtesy of Miriam Jones, USGS). Credit: Miriam Jones and USGS

Alaska's land mass is equal to the size of one-fifth of the continental United States, yet stores about half of the country's terrestrial—both upland and wetland - carbon stores and fluxes. The carbon is not only stored in vegetation and soil, but also in vital freshwater ecosystems even though lakes and ponds, rivers, streams, and springs only cover a small amount of landmass in Alaska.

Alarmingly, recent studies show that Alaska is warming more than twice as fast as the rest of the country. The fate of the large state's plentiful carbon, and how carbon management policy is structured there, has implications on national, and even international, scales.

A collection of articles in the Ecological Society of America's journal *Ecological Applications* provides a synthesis of the Alaska terrestrial and aquatic carbon cycle. "Taken as a whole, the set of papers in the invited feature provide a comprehensive view of a critical region, and one that could be a model for other regions within the U.S. and globally," USGS researcher David McGuire writes in the feature's introduction.

The warming climate in northern ecosystems such as Alaska's can release carbon dioxide (CO_2) and other gases into the atmosphere through many pathways, including but not limited to the thawing of methane-laden permafrost and increased carbon emissions from more frequent wildfires.

However, other aspects of the carbon cycle could counter the increased carbon release. Warmer, longer growing seasons and more available nutrients may result in more green growth to take up more atmospheric CO_2, providing a sink. The types of forests that grow at high latitudes could shift from more flammable conifer forest to less flammable deciduous forest, meaning fewer wildfires.

USGS scientists conducting research on a boat on the Yukon River, between Eagle and Circle, Alaska. Photo courtesy of Mark Dornblaser, USGS. Credit: Mark Dornblaser, USGS

Together, the papers provide new syntheses of Alaskan carbon stores and fluxes, fire dynamics, vegetation change, forest management, permafrost soil thaw, and many other facets of historical (1950-2009) and projected (2010-2100) carbon balance in these sensitive ecosystems.

These papers stem from efforts by the U.S. Geological Survey, U.S. Forest Service, and university scientists to assess past and future carbon fluxes as mandated by the Energy Independence and Security Act of 2007. The original report, a first-of-its-kind assessment published in 2016, revealed the vulnerability of carbon stored in high latitude ecosystems and how soil carbon losses in Alaska are amplified by wildfires with the warming Arctic climate.

McGuire explains ways in which future assessments can be even more comprehensive, such as modeling the future methane emissions from lakes and including the effects that fire disturbances have on insects and abrupt thawing. In addition, he recommends that future assessments extend to 2300 given that many effects of permafrost thaw and elevated atmospheric CO_2 have not yet fully manifested, and those assessments should include societal impacts of climate change in Alaska.

As demonstrated by the 2016 report, and further emphasized by these new publications, it is absolutely vital to pursue a field-based understanding of the carbon cycle of the Earth in various settings in order to better understand both the natural and the human-influenced mechanisms of climate change.

More information: A. David McGuire, et al. (2018) Introduction for invited feature "Alaska Carbon Cycle." *Ecological Applications*. DOI: 10.1002/eap.1808

A. David McGuire, et al. (2018) Assessing historical and projected carbon balance of Alaska: A synthesis of results and policy/management implications. *Ecological Applications*. DOI: 10.1002/eap.1768

Hélène Genet, et al. (2017) The role of driving factors in historical and projected carbon dynamics of upland ecosystems in Alaska. *Ecological Applications*. DOI: 10.1002/eap.1641

Zhou Lyu, et al. (2018) The role of environmental driving factors in historical and projected carbon dynamics of wetland ecosystems in Alaska. *Ecological Applications*. DOI: 10.1002/eap.1755

Neal J. Pastick, et al. (2017) Historical and projected trends in landscape drivers affecting carbon dynamics in Alaska. *Ecological Applications*. DOI: 10.1002/eap.1538

Sarah M. Stackpoole, et al. (2017) Inland waters and their role in the carbon cycle of Alaska. *Ecological Applications*. DOI: 10.1002/eap.1552

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