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Carbon Emissions from Western Siberian Inland Waters

Svetlana Serikova

Akademisk avhandling

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Fakultetsopponent: Professor of Ecosystem Ecology,
Dr. Peter Raymond,
School of Forestry and Environmental Studies/Yale University,
New Haven, USA.

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Author
Svetlana Serikova

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Abstract
Inland waters (i.e. rivers, streams, lakes, ponds) emit carbon (C) into the atmosphere. The magnitude of global inland water C emission has been estimated to equal the global ocean C sink, thus making inland waters an important component of the global C cycle. Yet, the data used in estimating the magnitude of global inland water C emission lacks measurements of inland water C emissions from permafrost-affected regions in general and from Russia in particular, despite permafrost covering ~25% of the Northern Hemisphere and ~65% of Russia. This lack of data questions the accuracy of the current estimate of global inland water C emission and its predictive power in assessing changes in the global C cycle following permafrost thaw.

In this thesis, we conducted detailed measurements of river and lake C emissions across ~1000 km permafrost gradient of Western Siberia (from permafrost-free to continuous permafrost zone) and assessed the magnitude of the total C emission from Western Siberian inland waters. We found that river and lake C emissions varied across the permafrost gradient with river C emissions being greatest in areas where permafrost is actively degrading, and lake C emissions being greatest in areas where permafrost is still intact. We also found that river and lake C emissions are likely driven by different factors with river C emissions being mainly controlled by temperature and hydrological conditions, whereas lake C emissions by sediment respiration and availability of recently thawed organic C. Further, we estimated the total C emission from Western Siberian inland waters to be greater than previously thought and exceeding the C export from this region to the Arctic Ocean. Such finding implies that a major part of the terrestrially-derived C is lost in Western Siberian inland waters, making this region a hotspot for inland water C emission following permafrost thaw. We also showed that apart from C emissions measurements across different inland water types and across the landscape, estimates of inland water surface areas are needed for accurate assessments of the total inland water C emission of any given region. Particularly, water surface areas of streams and ponds as well as inundated floodplains, especially in years of extreme flood events, are important for quantifying the total inland water C emission. Overall, this thesis presents new data related to C emissions from rivers and lakes in an area that undergoes rapid permafrost thaw, and urges to account for all inland water types and their respective water surface areas when attempting to achieve unbiased estimates of the inland water contribution to the atmospheric C budget.

Keywords
carbon, carbon dioxide, methane, carbon emissions, river, lake, inland waters, permafrost, Siberia

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