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Mapping of West Siberian taiga wetland complexes using Landsat imagery: Implications for methane emissions

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Boreal wetlands are important for understanding climate change risks because these environments sink carbon dioxide and emit methane. The West Siberia Lowland (WSL) is the biggest peatland area in Eurasia and is situated in the high latitudes experiencing enhanced rate of climate change. However, fine-scale heterogeneity of wetland landscapes poses a serious challenge when generating regional-scale estimates of greenhouse gas fluxes from point observations. A number of peatland maps of the West Siberia was developed in 1970s, but their accuracy is limited.

In order to reduce uncertainties at the regional scale, we mapped wetlands and water bodies in the WSL on a scene-by-scene basis using a supervised classification of Landsat imagery. Training data consisted of high-resolution images and extensive field data collected at 41 test areas. The classification scheme aimed at supporting methane inventory applications and included 7 wetland ecosystem types comprising 9 wetland complexes distinguishable at the Landsat resolution. To merge typologies, mean relative areas of wetland ecosystems within each wetland complex type were estimated using high-resolution images. Accuracy assessment based on 1082 validation polygons of 10×10 pixels indicated an overall map accuracy of 79%.

The total area of the WSL wetlands and water bodies was estimated to be 70.78 Mha or 5-17% of the global wetland area. Various oligotrophic environments are dominant among wetland ecosystems, while different fens cover only 14% of the area. Taiga zone contains 75% of WSL's wetlands; their distribution was described in detail by Terentieva et al. (2016). Concerning methane emission, taiga contributes 85% to regional methane flux and tundra only 8%, however ebullition in tundra lakes was not directly measured. Elevated environments as forested bogs and ridges emit at the lowest rates of methane emission. They account for only 2% of the regional total emissions occupying almost 40% of the wetland area. Depressed environments as different types of hollows contribute 96% to the methane regional flux, covering 50% of the wetland area in the region.

Applying the new map resulted in total methane emissions of 4.62 TgCH4/yr, which is 72% higher than the earlier estimate based on the same emission dataset and the less detailed map by Peregon et al. (2009). The revision resulted from the changes in fractional coverages of methane emitting ecosystems due to the better spatial resolution of the new map. The new Landsat-based map of WSL wetlands provides a benchmark for validation of coarse-resolution global land cover products and wetland datasets in high latitudes.

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