MAPPING NPP AND BIOMASS IN WEST SIBERIAN WETLANDS

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ABSTRACT

The objective of this study is to provide improved estimation of the area extent for major mire types within West Siberia (WS) and determine the spatial variability of NPP and biomass in relation to macro/micro landscape and site position within the bioclimatic division. Our approach relies upon scaling up available field survey and literature data to provide wetland net primary production (NPP) and biomass inventory maps for West Siberia. Both, satellite images and aerial photography classifications have been used to extrapolate site data into a regional inventory map (1:2.5M scale). Total NPP of wetlands is estimated as 530.5 TgDM (teragram/megaton dry matter)yr^{-1}, or 624.4 TgDM/yr when woody parts are included. Lowest NPP has been assigned to wetlands at the northern part of Taiga zone (4.5-6.2 tonDM)/ha/yr^{-1}). Wetlands in Tundra, Forested tundra and southern parts of Taiga zone show considerably higher NPP values. Minimum of living biomass storage was found in middle and southern taiga subzones. It is also increased to the north and south within West Siberian territory.

INTRODUCTION

It is important to identify the potential range and spatial distribution of NPP and carbon storage responses to elevated atmospheric greenhouse gases and global warming. Earlier studies [e.g., *Bartsch and Moore*, 1985; *Moore et al*., 2002; *Van der Valk and Bliss*, 1971] have estimated spatial variability of NPP and biomass values in relation to latitude and presence of topography (ridges, hummocks, etc.). We have only limited data available about distribution of the major wetland types for different parts of large Siberian territory. About 5-6 general vegetation classes provide global models of CO_2 and methane emissions with a realistic estimate of current landcover at coarse spatial resolution [*Matthews and Fung*, 1987; *Aselmann and Crutzen*, 1989; etc.]. It is necessary to develop detailed wetland inventories as the base for further research.

MATERIALS AND METHODS

Our own field survey data were obtained within Taiga zone for major types of wetland micro-landscapes with subdivision to the following fraction: above-ground (ANP), land-surface (LNP) and below-ground (BNP) components. To obtain reasonable results, three test areas for our observations were selected in different locations along a wide N-S climate gradient. In addition to out own data we used 91 NPP and biomass estimations by other authors, found in scientific literature for boreal and northern wetlands.

In order to compile regional inventory, we have developed multi-scale approach, in which we use a digitized regional "Wetland typology map" (1:2.5M scale, 20 wetland classes) [*Romanova et al*., 1977], further refined by satellite image classifications (Landsat, SPOT, Resurs, at 1:100 – 1:200K scale). Satellite images for test areas within Taiga Zone of Western Siberia are classified using common classification system (30 wetland classes). For evaluation of area fraction occupied by micro-landscape elements within patterned wetlands we used aerial photography (1:25K scale). As a result, we produced a GIS map-based inventory of ecosystem

NPP and biomass storage in West Siberian wetlands, using observation on all major micro landscape elements and area fraction of those landscape elements estimated for each wetland class on the regional scale map.

RESULTS AND DISCUSSION

According to Wetland typology map, wetlands cover $668\times10^9 m^2$ or 26% of total West Siberian area, with maximum fraction in Taiga zone (about 30%) and minimum in northern tundra of about 7%.

Most of NPP is estimated to occur in Taiga zone (320.8 TgDM/yr), with maximum contribution from southern subzone (60%). Other parts contribute less: 21% middle taiga, and 19% northern taiga. Most productive are forested wetlands and ridges, their contribution is about 56% in whole taiga region. 15% of total NPP in taiga is contributed by mesotrophic and eutrophic hollows, in spite of their minor area fraction, they are productive (35TgDM/yr total). In tundra region wetland NPP is 45 TgDM/yr, in forested steppe and steppe area NPP is about 165 TgDM/yr.

Adding woody layer increases the total NPP and phytomass values. Of course, the productivity of woody layer varies with density and canopy height, but the total phytomass storage is minor (164 TgDM) and NPP is 93.9 TgDM/yr. Total NPP of West Siberian wetlands is estimated as 530.5 TgDM (teragram/megaton dry matter)yr^{-1}, or 624.4 TgDM/yr when woody parts are included.

West Siberian wetlands have a significant NPP, with contributions from high productivity of mosses (up to 40%) and below-ground fraction of vascular plants (more than 60% in southern taiga). NPP of wetlands increases from north to south in Taiga zone (Table 1). Increase of below-ground NPP fraction and reduction of moss species contribution have been registered in the same direction.

Table 1. Average NPP ($gDM/m^2/yr^{-1}$) by Vegetation Layer

Latitudinal Division	Average NPP, $gDM/m2/yr^{-1}$	NPP fraction by vegetation layer			Average Biomass, gDM/m2
		Above-Ground, %	Land-Surface (mosses), %	Below-Ground, %	
Northern taiga	354-958	11	38	51	770-2400
Middle taiga	500-887	13	40	47	970-1748
Southern taiga	527-1970	10	28	62	883-3570

Living biomass storage of wetlands reaches 10-30% of total biomass storage of upland forest ecosystems in the same bioclimatic zone. On the contrary, NPP value on the wetlands is higher in tundra, northern taiga and especially in southern grassland type wetlands (1.5-2 times larger, compared with forest NPP). NPP of wetlands and forests were found to be of a similar order in middle and southern taiga subzones.

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