

Carbon stocks in coarse woody debris in the middle taiga ecosystems located along the Yenisei river

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ABSTRACT

This paper presents the results of the assessment of carbon stocks in the coarse woody debris in the prevailing forest types of the middle taiga. Carbon stocks in down coarse woody debris were estimated to total 58.2 million tonnes, 80% of which were found in dark conifer stands, 10% in deciduous forests, and 10% in pine forests and pine logging. In pine forests of the two dominant groups of forest types and pine logging, carbon stocks amounted to 1.5–3.3 and 1.2 million tonnes, respectively. The values obtained in this study will be used to develop a database on ecosystem components required for quantifying carbon storage and fluxes.

KEY WORDS

carbon stocks, coarse woody debris, database, dark conifer stands, deciduous forests, pine forests, pine logging

INTRODUCTION

Forest ecosystems of the boreal zone constitute the huge reservoir of accumulation of atmospheric carbon in above- and belowground phytomass and soil. Dead wood is formed during natural processes of dying and dropping out trees. Fires, blowing winds, abnormally low temperatures and other adverse effects of anthropogenic and natural causes lead to the formation of coarse woody debris (CWD) (Stakanov et al. 1994). CWD is a part of dead organic matter in soil, which is the most powerful reservoir of carbon accumulation in forest ecosystems (Isaev and Korovin 1999). The flux of carbon dioxide during decomposition of CWD is substantial, and therefore must be included in the assessment of carbon balance of forest ecosystems (Za-

molodchikov 2009). Typically, carbon stocks of dead-wood in investigations on parameters of ecosystems are conducted only in the areas of high congestion or are completely ignored, which significantly reduces the accuracy of estimates of total carbon stocks (Treyfeld and Krankina 2001). Currently, stocks of carbon accumulated in dead organic matter of forest ecosystems of the boreal zone are not determined properly, and for the correct assessment of dead organic matter pool it is necessary to create a database on stocks of carbon in forest litter and coarse woody debris (Isaev and Korovin 1999).

The purpose of this study was the assessment of total carbon stocks in coarse woody debris (Fallen trunks and stumps) in a radius of 100 km of the international observatory ZOTTO, in Siberian middle taiga.

MATERIAL AND METHODS

This study was conducted in taiga forest ecosystems of central Siberia located along the Yenisei river. Research on carbon stocks in coarse woody debris was conducted within a radius of 100 km of the international observatory ZOTTO (Zotino Tall Tower Observatory) (60° N, 89° E) (Kozlova et al. 2008). The area of research is related to the Sym-Dubches district of forests in the middle taiga (Korotkov 1994). In the district, there grow pine, fir, larch, birch and aspen forests dominated by coniferous trees (Pleshikov et al. 2002). Pine forests belong to two dominant types – green-moss and lichen.

To identify sites with similar vegetation types for research, there was carried out automated classification of satellite images LANDSAT ETM+. The analysis of satellite data identified 11 classes of aggregated land surface and showed that the forest area was about 84%. Dark coniferous communities were determined to occupy about half of the area of interest, pine forest – 16%, deciduous forests – 12% and about 3% – pine logging (pine cuttings). Dark coniferous forests were represented by the Siberian fir (*Abies sibirica* Ledeb.), Siberian spruce (*Picea obovata* Ledeb.) and Siberian pine (*Pinus sibirica* Du Tour). Research on carbon stocks in coarse woody debris was carried out on 218 plots, of which: 71 plots were embedded in green-moss pine forest, 28 plots – in lichen pine forest, 15 plots – in pine logging, 35 plots – in cedar (*Cedrus* spp.) stands, 18 plots – in fir (*Pseudotsuga* spp.) plantations, 9 plots – in spruce (*Picea* spp.) stands and 42 plots in deciduous forests.

Based on satellite imagery there were selected transects with sample plots. The distances between plots in the direction N-S and W-E were equal to 1 km. Lined up transects covered the most representative areas of forest in the study district.

Coarse woody debris was divided by the stage of decomposition and type of wood, which allowed determining carbon stocks most accurately.

RESULTS

Average carbon stocks in coarse woody debris on the study area for dark conifer forests amounted to $28.1 \pm 8.8 \text{ t} \times \text{ha}^{-1}$, for deciduous forests – $15.0 \pm 4.0 \text{ t} \times \text{ha}^{-1}$,

for green-moss pine forests – $12.2 \pm 2.8 \text{ t} \times \text{ha}^{-1}$, for lichen pine forests – $6.6 \pm 1.5 \text{ t} \times \text{ha}^{-1}$ and for pine logging – $14.0 \pm 3.1 \text{ t} \times \text{ha}^{-1}$. The coefficient of variation was 31% for dark conifer forests and 22–26% for other ecosystems.

Common stocks of coarse woody debris carbon in the studied ecosystems, located in a radius of 100 km from the measurement tower (3.14 million hectares area) were estimated to reach 46.2 ± 14.5 million tonnes for dark conifer communities, 6.2 ± 1.7 million tonnes for deciduous forests, 3.2 ± 0.8 million tonnes for green-moss pine forests, 1.5 ± 0.3 million tonnes for lichen pine forests and 1.1 ± 0.3 million tonnes for pine logging (Fig. 1).

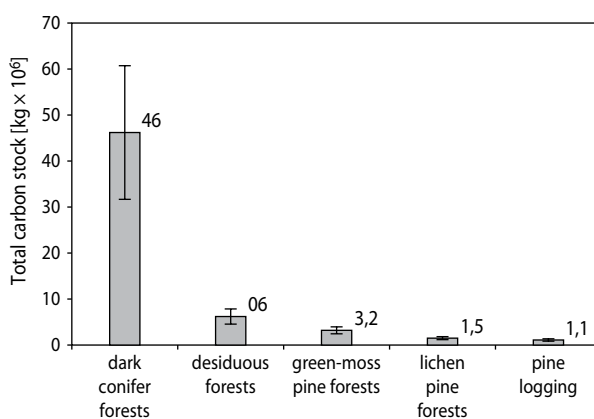


Fig. 1. Total stocks of carbon in CWD in the prevailing forest types in vicinity of (100 km radius) Zotino Tall Tower Observatory (ZOTTO)

The analysis of carbon stocks in the two dominant pine forest types occupying almost the same area showed that green-mosstype contained 2 times more carbon than the lichen type. Higher amounts of carbon in CWD observed in green-moss pine forests are due to advanced productivity and less frequent exposure to the pyrogenic factor.

The present study is a part of the work on inventory parameters of terrestrial ecosystems carried out in the area of coverage by the observatory ZOTTO. The obtained data on stocks of carbon in CWD in this area are needed to form a regional database connected with the middle taiga.

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