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Fire impact on carbon emissions and ecosystems components in conifer forests of Siberia

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Fires cover annually millions ha of closed boreal forests, of which the biggest part is in Siberia. Emissions released from biomass burning influence atmospheric chemistry and global carbon cycling. In effort to assess fire influence on carbon balance, emissions, and forest ecosystem sustainability, experimental fires aimed at modeling fire behavior were conducted in larch and Scots pine stands of central Siberia in the framework of Fire Bear (Fire Effects in the Boreal Eurasia Region) Project. Carbon emission ranged 2.39 to 22.60 t C/ha in our experimental surface fires in Scots pine stands. The greatest amount of carbon released from feather moss, lichen, and forest floor burning (60-80% of the total carbon emission). A close correlation was found between fire carbon emission and weather conditions. Fire influenced all forest ecosystem components including the overstory, living ground vegetation, soil structure, microorganisms, and invertebrates. Our long-term experiments allowed us to identify vegetation succession patterns after fires of known behavior. Ground vegetation in Scots pine plots was determined to degrade after fires of any intensity, where it was dominated by small shrubs, lichens, and feather moss. The initial postfire succession stage is known to depend on site conditions, pre-fire forest type, and the last fire type and severity. Fires have a profound impact on forest-atmospheric carbon exchange and make ecosystem carbon sources for a long time after burning. Southern and central taiga Scots pine stands with lichen- and feather moss-dominated ground vegetation were carbon sinks prior to burning; they accumulated 1.4-1.7 t C/ha annually. First several post-fire years carbon efflux increased due to increasing tree mortality and duff accumulation. As a result, these stands functioned as carbon sources releasing -1.39 to -1.85 tC/ha/yr and -0.03 to -0.25 tC/ha/yr after a high- and a low-intensity fire, respectively. Fire frequency has increased in boreal forests over the past several decades and is expected to increase more under climate change. This would result in greater carbon loss and efflux to the atmosphere.

Keywords: forest fire, fire intensity, boreal forests, postfire succession, ecosystem, carbon balance