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Change in carbon dioxide absorption by a deciduous broadleaf forest due to the 2004 typhoon disturbance

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Natural disturbances occur in forests at various scales and frequencies. It has an impact on the amount of carbon dioxide (CO_2) absorption by a forest. In Japan, large-scale disturbance often occurs in forests due to damage caused by strong winds of a typhoon. The 18th typhoon passing in 2004 brought about large-scale damage to forests, mainly in Iburi and Ishikari districts of Hokkaido. The Hitsujigaoka experimental forest (Sapporo forest meteorology research site, SAP) located in the southeastern area of Sapporo also suffered large-scale damage. An investigation related to CO_2 absorption, including flux observation, was conducted before the typhoon disturbance. After a 1-year interruption of the investigation due to facility damage by the typhoon, flux observation was reinitiated. To study the process of regeneration in the forest, the fallen trees were left into site. We report the results of a long-term observation of flux and biomass.

According to flux observation data, the annual carbon budget changed to negative after the disturbance. At present, carbon release is continuing. The supply of a lot of dead trees has caused a large amount of decomposition, which has lead to 1.5-fold heavy increases in ecosystem respiration. Meanwhile, average annual GPP from 2007 to 2012 decreased 5% compared with that before the typhoon.

Yearly maximum LAI including both trees and dwarf bamboo estimated by the attenuation rate of photosynthetically active radiation and the biomass survey was approximately 7 before the disturbance. It decreased to 4 in the following year and increased thereafter. It has been approximately 5.5 since 2007. The main source of total LAI recovery is the LAI of dwarf bamboo, which increased 2-fold. The amount of biomass of trees decreased to 70% after the typhoon, while that of dwarf bamboo increased 1.5-fold. However, biomass of bamboo was approximately 10% of that of trees. Therefore, dwarf bamboo did not fill in gaps due to a decrease in biomass of trees.

Photosynthetic increase due to dwarf bamboo partially compensated for photosynthetic decrease due to trees, and ecosystem respiration increased due to the increase in dead trees. As a result, the forest became the carbon source. To change the status of the forest from the carbon source to a carbon sink, it is necessary for carbon release to decrease with the advancing decomposition of dead trees.

Keywords: deciduous broadleaf forest, dwarf bamboo, CO_2 flux, disturbance