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Impacts of forest defoliation by pine wilt disease on biogeochemical cycling and streamwater chemistry in a headwater catchment in central Japan

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Pine wilt disease (PWD) can be treated as a semi artificial forest disturbance, because the causal agent was originally introduced from North America through the timber trading, and several previous studies showed that the forest defoliation by PWD has been accelerated by physiological damages caused by air pollutions. The intensive incidence was observed in the early 1990's at the Kinki district of central Japan. In order to evaluate the impact of partial dieback of dominant tree stands, changes in nutrient status in soils and streamwater chemistry was investigated in a small headwater catchment, especially focusing on the nitrogen dynamics, accompanied with hydrological monitoring. Decreased N uptake by roots and increased N supply from litter fall caused by the 1992-1994 pine dieback caused a threefold increase in NO_3^- and cations (Ca^{2+} and Mg^{2+}) concentrations of streamwater and subsurface groundwater. It was found that seasonal peaks in stream NO_3^- concentration during the rainy season (July to August) occurred during 1992-1996. This seasonal variation corresponded directly to that of the groundwater level at the riparian zone near the catchment outlet. This suggested that seasonality in groundwater level is the dominant factor controlling temporal changes in stream NO_3^- concentration. The mechanism of seasonal pattern found in this watershed can emphasize the importance of hydrological seasonality with high precipitation, groundwater level and runoff rate in summer of Japan, while the smaller inorganic nitrogen pools and low transportation forces can affect simultaneously on NO_3^- leaching during summer in the European and eastern United States forested watersheds. The N contribution of PWD litter inputs was 7.39 kmol ha^{-1} during the defoliation period, and nitrogen loss through the streamwater was less than 0.5 kmol ha^{-1} $year^{-1}$ throughout the observation period. This large discrepancy suggested substantial nitrogen immobilization in soils.

Keywords: pine wilt disease; forest defoliation; nitrogen dynamics; streamwater chemistry; hydrological processes