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Ammonium Nitrogen Deposition as a Dominant Source of Nitrogen in a Forested Watershed Experiencing Acid Rain in Central Japan

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Abstract To clarify nitrogen (N) sources, the overall N budget in a forested watershed in Kanagawa Prefecture, Central Japan was estimated by measuring dissolved inorganic N (DIN; $NH_4^+ + NO_3^- + NO_2^-$) from Nov 2004 through Oct 2005. The estimated N budget (–1.43 kg N ha^{-1} $year^{-1}$) showed that the N output rate (stream water N) was higher than the N input rate (bulk deposition N) in the watershed. The annual NO_2^- and NO_3^- input rates were 0.02 and 1.99 kg N ha^{-1} $year^{-1}$, respectively. NH_4^+ was the predominant source in this forested watershed, accounting for 71% (4.99 kg N ha^{-1} $year^{-1}$) of DIN input rate. In addition, this study estimated rainfall pH, air temperature, and wind direction, which were considered as controlling factors related to the atmospheric deposition rate of NH_4^+. This study showed that the rainfall NH_4^+ was inversely proportional to the initial pH of the rainfall, which was calculated by adding the amount of H^+ consumed by the dissociation process of $NH_{3(aq)}$ to the measured rainfall pH. This result implies that acid rain can elevate the solubility of $NH_{3(g)}$ and the dissociation capacity of NH_4^+ throughout the process of precipitation. Also, this study provides strong evidence that the high NH_4^+ deposition rate is mainly derived from $NH_{3(g)}$ emitted from livestock wastes under the NH_3 transport condition of warm summer and favorable wind direction.

Keywords Acid rain · Atmospheric N deposition · Livestock · N sources · Forested watershed · Central Japan

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1 Introduction

Atmospheric nitrogen (N) deposition rates in the temperate zone of western Europe, eastern Asia, and the eastern USA have dramatically increased during recent decades due to the emissions of NOx and ammonia (NH_3) gas from combustion processes and agricultural activities, respectively (Vitousek 1994; Galloway et al. 1995; Holland et al. 1999). Kannari et al. (2001) have reported that the total estimated NH_3 emissions (which make up 42% of NH_3+NOx emissions) in Japan primarily originated from agricultural areas (66% of total NH_3 emission) and urban

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