Nitrogen export via surface water from an agriculture watershed in the Taihu Lake area, China

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Key words: non-point source pollution, rice-wheat cropping region, land use, soil erosion, sediment/water-associated nitrogen loss

Objectives

Situated in the center of the Yangtze River Delta, one of China's most important rice-wheat cropping areas as well as most developed economic zones, Taihu Lake has become severely eutrophicated. The Chinese government has resolved to combat this pollution by closing a large number of heavy-polluting enterprises, and by banning the distribution and use of P-bearing detergents in its catchment area. Nevertheless, water quality of the lake has not shown any significant improvement in recent years. Increased nutrient loss from arable land due to the nutrient surplus in agricultural systems was suggested as its main reason. However, that information in the area had been very limited. To address this problem, in one of typical watersheds in the area, the Meilin Watershed, Yixing City, Jiangsu Province (31°20'N, 119°51'E; 1.22 km^2; Fig. 1), temporal changes in N concentrations in stream water (Fig. 2) and stream discharge, as well as sediment and N losses from erosion plots with different land uses (Fig. 3), were investigated.

Results

Much higher runoff, sediment and N losses were observed under upland cropping and vegetable fields than under chestnut orchards and bamboo thickets (Fig. 3). Sediment-associated N losses accounted for 8–43.5% of total N discharge via overland runoff. N lost in dissolved inorganic N forms accounted for less than 50% of total water-associated N discharge. Agricultural practices and weather-driven fluctuation in discharge were main reasons for the temporal variations in nutrient losses via stream discharge (Fig. 2). Significant correlation between the total N concentration and stream discharge load was monitored. N losses from the studied watershed via stream discharge between mid-May 2002 and mid-May 2003 were estimated to be 20.3 kg N/ha. From farmers' interviews, it was estimated to be equivalent to 8.5% of the applied N in this watershed. This indicates that 16 mg of N was loaded into each liter of Taihu Lake water per year, if we assume that there was the same intensity of N load from the whole catchment area and that all the N was accumulated in the lake.

Combined with the results of township-level investigation obtained at Xuyan Town, Wujin City, Jiangsu Province (33 km^2), about 27 km East-Northeast from the Meilin, the intensities of N load from agricultural land, village, town centers and poultry farming were estimated at 48, 40, 10 and 2%, respectively, suggesting that agricultural activity was the leading source of N pollution in this region.

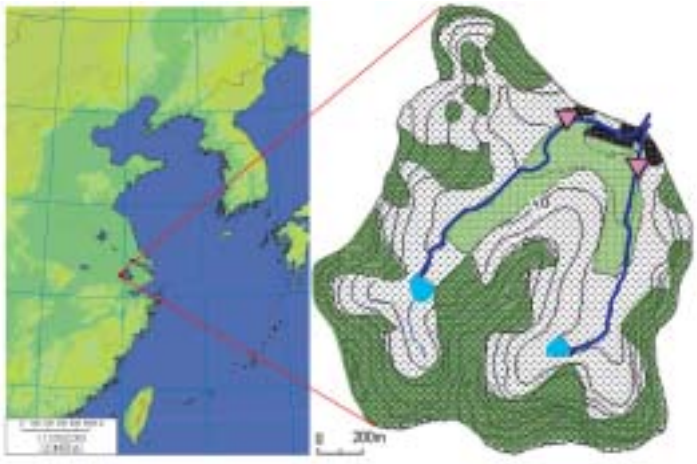

Fig. 1. Location, land use and topographical map of the Meilin Watershed, Yixing City, Jiangsu Province, China. A typical agriculture watershed on the west coast of Taihu Lake was targeted, with paddy fields ( ) at the bottom of valleys around two channels ( ); upland fields and orchards ( ), and bamboo and other woods ( ) near the slopes. The lower reaches of channels are populated areas ( ), but almost no habitation can be found above the weirs ( ) where water flux and quality were investigated.

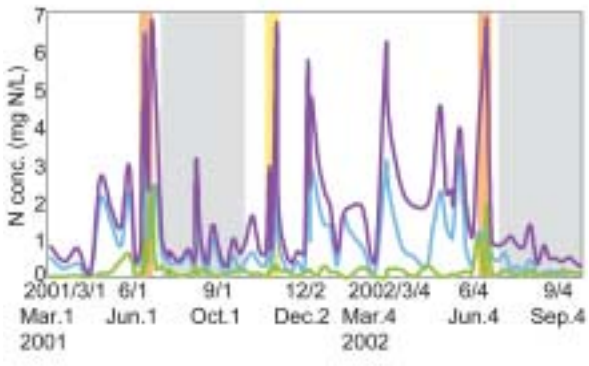

Fig. 2. Nitrate ( ), ammonium ( ) and total ( ) nitrogen concentrations in outlet channel water from the Meilin Watershed (see Fig. 1). Channel water was sampled at the weirs on a weekly basis during baseflow, and more intensively for 14 hours after significant rainfall events. : July-September when rice was in its full growing season, : basal fertilizer application for rice, : basal fertilizer application for rape and wheat.

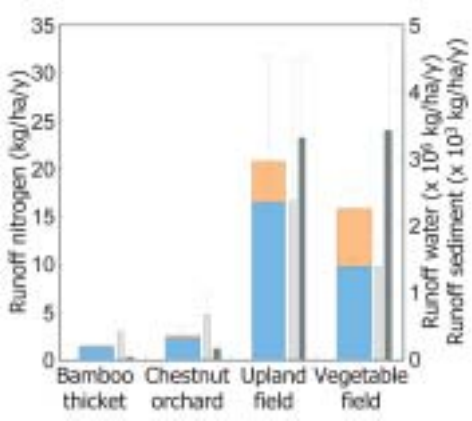

Fig. 3. Effects of typical upland water usage for bamboo thickets, chestnut orchards, upland fields and vegetable fields, at slope areas showing amounts of runoff water ( ), sediment ( ), sediment-associated nitrogen ( ) and water-associated nitrogen ( ) observed for a year in 2002 when remarkable runoff events were observed 12 times following heavy rainfall events. Vertical bars indicate the SDs of duplicate measurements.

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