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Temporal-spatial patterns of three types of pesticide loadings in a middle-high latitude agricultural watershed

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Abstract

Pesticide loadings to watersheds increase during agricultural development and may vary in accordance with different crop types and seasons. High pesticide loadings can potentially result in polluted stream water. The objective of this study was to determine the pesticide loadings and concentrations of three typical pesticides (atrazine, oxadiazon, and isoprothiolane) in river water from a middle–high latitude agricultural watershed in northern China. During this study, we evaluated the watershed pesticide loss patterns for two crop types over three decades. For this purpose, we integrated data from field investigations, laboratory experiments, and modeling simulations involving a distributed hydrological solute transport model (Soil and Water Assessment Tool, SWAT). SWAT was employed to compare the temporal–spatial fate and behaviors of atrazine, oxadiazon, and isoprothiolane from 1990 to 2014 in a watershed area amounting to 141.5 km^2. The results showed that the three pesticides could be detected at different locations throughout the watershed, and isoprothiolane was detected at the maximum value of 1.082 μg/L in surface runoff of paddy land. The temporal trend for the yearly loading of atrazine decreased slightly over time, but the trends for oxadiazon and isoprothiolane increased markedly over an 18-year analysis period. In regard to the pesticide concentrations in water, atrazine was associated with the largest value of nearly 1.4 μg/L. July and August were the found to be prime periods for pesticide loss from paddy land, and the biggest monthly loss of atrazine from dryland appeared in June. Under similar usage conditions, isoprothiolane loading from paddy fields ranked as the largest one among the three types of pesticides and reached up to 17 g/ha. Limited monitoring data were useful for validating the model, which yielded valuable temporal–spatial data on the fate of pesticides in this watershed. With the expansion of paddy rice cultivation, risks for pesticide contamination of water bodies will increase. The results of this study should be valuable for future exposure and risk assessments aimed at protecting the environment and human health.

Keywords: Pesticide; Diffuse pollution; Water quality; Agricultural exploitation; Watershed modeling

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