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Classifying hydrological events to quantify their impact on nitrate leaching across three spatial scales

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Nitrate is one of the most important sources of pollution for surface waters in tile-drained agricultural areas. In order to develop appropriate management strategies to reduce nitrate losses, it is crucial to first understand the underlying hydrological processes. In this study, we used Principle Component Analysis (PCA) and Linear Discriminant Analysis (LDA) to analyze 212 storm events between 2004 and 2011 across three spatial scales (collector drain, ditch, and brook) to identify the controlling factors for hydrograph response characteristics and their influence on nitrate concentration patterns. Our results showed that the 212 hydrological events can be classified into six different types: summer events (28%), snow-dominated events (10%), events controlled by rainfall duration (16%), rainfall totals (8%), dry antecedent conditions (10%), and events controlled by wet antecedent conditions (14%). The relatively large number of unclassified events (15%) demonstrated the difficulty in separating event types due to mutually influencing variables. NO_3-N concentrations showed a remarkably consistent pattern during the discharge events regardless of event type, with minima at the beginning, increasing concentrations at the rising limb, and maxima around peak discharge. However, the level of NO_3-N concentrations varied notably among the event types. The highest average NO_3-N concentrations were found for events controlled by rainfall totals (NO_3-N=17.1 mg/l), events controlled by wet antecedent conditions (NO_3-N=17.1 mg/l), and snowmelt (NO_3-N=15.2 mg/l). Average maximum NO_3-N concentrations were significantly lower during summer events (NO_3-N=10.2 mg/l) and events controlled by dry antecedent conditions (NO_3-N=11.7 mg/l). The results have furthermore shown that similar hydrological and biogeochemical processes determine the hydrograph and NO_3-N response on storm events at various spatial scales. The management of tile-drained agricultural land to reduce NO_3-N losses should focus explicitly on flow events and, more specifically, active management should preferably be conducted in the winter season for discharge events after snowmelt, after heavy rain storms and when the soil moisture conditions are wet.