Modeling nitrate contamination of groundwater in agricultural watersheds

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Summary This paper presents and implements a framework for modeling the impact of land use practices and protection alternatives on nitrate pollution of groundwater in agricultural watersheds. The framework utilizes the national land cover database (NLCD) of the United State Geological Survey (USGS) grid and a geographic information system (GIS) to account for the spatial distribution of on-ground nitrogen sources and corresponding loadings. The framework employs a soil nitrogen dynamic model to estimate nitrate leaching to groundwater. These estimates were used in developing a groundwater nitrate fate and transport model. The framework considers both point and non-point sources of nitrogen across different land use classes. The methodology was applied for the Sumas—Blaine aquifer of Washington State, US, where heavy dairy industry and berry plantations are concentrated. Simulations were carried out using the developed framework to evaluate the overall impacts of current land use practices and the efficiency of proposed protection alternatives on nitrate pollution in the aquifer.

Introduction

Agricultural activities are probably the most significant anthropogenic sources of nitrate contamination in groundwater (Carey and Lloyd, 1985; DeSimone and Howes, 1998; Gusman and Mariño, 1999; Birkinshaw and Ewen, 2000; McLay et al., 2001; Ledoux et al., 2007; Oyarzun et al., 2007). Elevated nitrate concentrations in drinking water can cause *methemoglobinemia* in infants and stomach cancer in adults (Lee et al., 1991; Wolfe and Patz, 2002). As such, the US Environmental Protection Agency (US EPA) has established a maximum contaminant level (MCL) of 10 mg/l NO_3-N (US EPA, 1995). Nitrogen is a vital nutrient to enhance plant growth. This fact has motivated the intensive use of nitrogen-based fertilizers to boost up the productivity of crops in many regions of the world (see for instance Laftouhi et al., 2003). Nevertheless, when nitrogen-rich fertilizer application exceeds the plant demand and the

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