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Research papers

An innovative approach to identifying agricultural pollution sources and loads by using nutrient export coefficients in watershed modeling

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ABSTRACT

Agricultural nonpoint source (ANPS) pollution has become a major reason for eutrophication in many regions of the world. However, it is still difficult to identify the relative contributions of different ANPSs to the nutrient export flux at the watershed outlet due to a lack of effective methods. The export coefficient approach (ECA) and the Soil and Water Assessment Tool (SWAT), which is a process-based watershed simulation model with aquatic nutrient retention simulation modules, were implemented to identify the ANPS and its associated quantitative contributions in the Three Gorges Reservoir Region, China. By using the SWAT-ECA framework, nutrient loadings to the river reaches in the subbasin and the export flux at the outlet of the watershed, which were derived from individual agricultural sources in each subbasin, were quantified accordingly. The primary goal of this study is to quantify the pollutant loads from different agricultural sources by using SWAT-ECA. The proposed work was conducted in the Xiangxi River Watershed of the Three Gorges Reservoir Region, Hubei Province, China. The total nitrogen (TN) and total phosphorus (TP) loads that were generated from the agricultural sources were 1299.1 t a^{-1} and 97.4 t a^{-1}, respectively. Livestock production was the main source of the TN load, accounting for 82% of agricultural TN load. Livestock production and crop cultivation were the main sources of the TP load, accounting for 52% and 42%, respectively. The delivery ratios of N and P from the source areas to the watershed outlet were relatively high in the study watershed. TN (1234 t a^{-1}) and TP (87.1 t a^{-1}) from agricultural sources were ultimately released to the reservoir area, which accounted for 40.2% and 37.6%, respectively, of the total fluxes from the whole watershed. The comprehensive approach that is proposed in this study can be useful for identifying the contributions of individual agricultural sources to the nutrient export flux at the watershed outlet.

1. Introduction

It has been shown that nonpoint source (NPS) pollution is usually transported from diffuse sources in comparison with the point source (PS) (Cai et al., 2018; Fan et al., 2008). In recent years, NPS pollution is one of the rising issues that may have direct and indirect negative impacts on public health and the natural environment (Chen et al., 2016; Duncan, 2014; Li et al., 2011). In the United States, NPS pollution contributes to nearly 60% of the impairments of the water body (U.S. Environmental Protection Agency, 2013). In the Great Lakes Region, a number of large-scale watershed management programs have been conducted to alleviate the current stage of the water quality crisis (Keitzer et al., 2016; Yen et al., 2016; Scavia et al., 2017).

Meanwhile, potential threats caused by NPS pollution also occurred in China with great challenges (Shen et al., 2012). Fast-growing industrial, agricultural, and domestic activities have triggered numerous public issues in varying aspects. For example, in the Three Gorges Reservoir Region (estimated population of 30 million residents), NPS was responsible for 82% of the total pollution loads (Wang, 2012). The NPS commonly includes an urban nonpoint source (UNPS) and an

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