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Long-Term Assessment and Modeling of Agricultural Nitrate in Groundwater Systems of Thailand

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The chronic impact of chemical contamination of groundwater is more dreadful particularly in developing world where groundwater is the main assessable source for potable water. Undesirable chemical dissolution in groundwater may cause very serious health problems, whether the chemicals are naturally occurring or anthropogenic origin. Over the past few decades, the increase in population and advances made in farming technology has increase the demand for crops and livestock from the agricultural industry in Thailand, resulting in an increase in contaminants polluting soil and groundwater. Nitrate contamination in groundwater is a common problem in many parts of the world, including Thailand, arising from various reasons, e.g., intensive agriculture with excessive fertilization, unsewered sanitation in densely populated areas, or even from point sources such as irrigation of land by sewage effluents. Efforts in this paper were made to evaluate the level of nitrate contamination in Suphanburi and Kanchanaburi due to the intensive farming with excess fertilization. A total of 160 groundwater samples from domestic and monitoring wells at various depths (100 samples from < 30 m deep, and 60 samples from > 60 m deep) in the study area were collected and analyzed for nitrate (as NO_3-), K, sulphate (as SO42-) and other chemical parameters. NO_3- level in groundwater ranged from 0.18 to 151 mg/L (Ministry of Natural Resources and Environment maximum concentration level = 45 mg/L). Consistent K and NO_3- trends from municipal wells in the study area indicated that nitrate source was agricultural origin rather than sewer leakage. 30% of shallow groundwater samples (< 30 m) were detected with higher nitrate concentration than MCL whereas only 15% of groundwater samples taken from > 30 m were found contaminated, suggesting the direct association major nitrate contamination in groundwater aquifer with potential source on the ground surface. The numerical model in this study is based on a regional model of groundwater flow characteristics using the USGS 3D finite-difference code MODFLOW-2000 to simulate groundwater flow and water-level distributions. The regional groundwater flow model was coupled with MT3D to simulate nitrate transport at laboratory-scaled and at regional-scaled as well as to project long-term future nitrate migration characteristics. Future applications of the model can be used to test “what-if” scenarios to improve effectiveness and efficiency of potential nitrate management and monitoring programs.