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Groundwater phosphorus concentrations: global trends and links with agricultural and oil and gas activities

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Although observations show that anthropogenic phosphorus (P) can reach groundwater supplies, there has been no comprehensive evaluation of P in groundwater at the global scale. Additionally, there have been minimal studies on distributed sources, such as agriculture, and the effects of oil and gas activities on P contamination in groundwater are poorly understood. We compile and analyze 181,653 groundwater P concentrations from 13 government agencies and 8 individual research studies in 11 different countries in order to determine the extent of P pollution at the global scale. We find that every country with data has groundwater P concentrations that pose a significant risk of eutrophication to surface waters. In Canada and the United States, we study the relationship between land use, focusing on crop/pastureland, and increased P concentrations in groundwater. In Ontario and Alberta, two Canadian provinces with different histories of oil and gas development, we find areas with a high concentration of P groundwater pollution to coincide with regions of intense oil and gas activity. Understanding the effects of anthropogenic sources on phosphorus contamination of groundwater and identifying all possible pathways through which contamination can occur will assist regulators in planning and implementing effective strategies to manage groundwater and surface water quality and sustain ecosystem health.