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Nitrogen Dynamics and Hydrochemical Impacts of Rain-fed Agriculture: Case of the Palouse

Abstract.

Chemical fertilizer applications comprise the largest fraction of the anthropogenic perturbation that has doubled natural reactive nitrogen (N) inputs to the global terrestrial biosphere. In the semiarid Palouse region of southeastern WA, famed for its legendary "dryland" yields of cereal grains, long-term studies of nested agricultural catchments show how prevailing policies and farming practices interact with climate and hydrology to generate pervasive N saturation and a legacy of environmental impacts we are just beginning to understand. Environmental hydrologic tracers and soil water balances show that streamflow generation is dominantly via subsurface pathways, activated following replenishment of growing-season moisture deficits by winter precipitation. At the inception of streamflow, mobile residual N is available throughout soil profiles for flushing from fields into waterways, thereby contaminating most streamwater leaving these catchments with nitrate at 2-3 times the EPA maximum contaminant level. These N fluxes are about 5-20% of long-term average fertilizer application rates in the catchments, constituting fossil-fuel and nutrient losses to growers rationally trying to maximize yields in the face of weather uncertainty. A similar or even larger percentage of fertilizer N is lost by unknown pathways; conventional wisdom suggests that biological reduction of nitrate (denitrification) returns this N to the atmosphere as inert N_2, with some of the nitrogen "leaking" from the denitrification pathway in the form of the potent greenhouse gas N_2O. The potentially large GHG "footprint" of chemical agriculture is a focus of collaborative work in WSU's NSF-funded IGERT grant "Nitrogen Systems: Policy-oriented Integrated Research and Education (NSPIRE)".