Land use and climate variability amplify carbon, nutrient, and contaminant pulses: a review with management implications

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Abstract - Nonpoint source pollution from agriculture and urbanization is increasing globally at the same time that climate extremes have increased in frequency and intensity. We review over 160 studies and show how the interaction between land use and climate variability alters the magnitude and frequency of carbon, nutrient, and contaminant pulses in watersheds. We define pulses as large changes in concentrations/fluxes of materials over relatively short time periods. Agricultural and urban watersheds respond surprisingly similarly to climate variability due to extensive headwater alteration and loss of ecosystem functions to moderate runoff and temperature. In agricultural and urban watersheds, dissolved organic carbon concentrations/exports increase strongly with runoff. Nitrogen and phosphorus exports increase during floods (sometimes by an order of magnitude) and decrease during droughts. Greenhouse gas emissions (CH4 and N2O) show pulses in soils/riparian zones following storms, and there are diurnal/seasonal pulses in streams. Emerging questions include: (1) what influences lag times of contaminant pulses and ecosystem recovery (2) how will rising temperature influence watershed pulses, and (3) how can we improve predicting pulse dynamics by coupling sensor networks with manipulative experiments. Finally, we conclude with 7 recommendations for managing watershed pulses in response to the interactive effects of land use and climate change.