Goldschmidt 2022 Abstract
https://doi.org/10.46427/gold2022.12773

Water quality legacies of agriculture, urbanization, and strip mining in the Upper Missouri River Watershed

STEPHANIE A EWING[1], ROBERT A PAYN[1], ANN MARIE REINHOLD[1], ELIZABETH MEREDITH[2], CAITLIN MITCHELL[1], MADISON J FOSTER[1] AND SKYE KEESHIN[1]

[1]Montana State University

[2]Montana Bureau of Mines & Geology

Presenting Author: ewingsa@gmail.com

Human land use commonly transforms water quality by altering the pathway and biogeochemical evolution of environmental waters as they travel from soils to shallow aquifers to stream corridors. In the Upper Missouri River Basin, urban, industrial and agricultural landscapes are chronically subject to rising temperatures and diminishing winter snowfall, even as rainfall increases in some areas. In this changing hydrologic context, groundwater recharge and exchange with surface waters can both entrain and attenuate nutrients. The fate of these nutrients depends on the nature of the hydrologic interaction with soils and sediment. We present data and modeling results from three watersheds in Montana, USA, each subject to a distinct land use pressure: (1) dryland wheat production in the headwaters of the Judith River, (2) urban development in the headwaters of the Gallatin River, and (3) strip mining for coal and subsequent remediation in coulees supplying groundwater to Rosebud Creek, a tributary of the Yellowstone River. We examine geochemical tracers of water sourcing ($^{87}Sr/^{86}Sr$, $^{234}U/^{238}U$ activity ratio) and isotopic evolution of solute loads (nitrate-$\delta^{15}N$, sulfate-$\delta^{34}S$) in these systems to evaluate how land use interacts with soils, aquifers, and streams to govern water quality. In the Judith River headwaters, nitrate pollution from fertilizer and soil inputs is mitigated by practices that slow hydraulic residence times and promote denitrification, including the fallowing of upland soils and stock pond construction in riparian corridors. In the Gallatin River valley, nitrate and chloride from septic effluent enter shallow groundwater as infiltrating waters combine with mountain snowmelt, and are ultimately delivered to surface waters by emergent creeks. In the coulees supplying water to Rosebud Creek, sulfate concentrations reflect the interaction of infiltrated waters with pulverized and redistributed aquifer materials, and are diluted by the influx of low-sulfate waters. In all systems, inmixing of dilute groundwaters from adjacent source areas mediates the influence of human land use on water quality, and the combination of inert and bioactive tracers indicates biogeochemical processing in zones where water movement is slowed in the presence of abundant organic carbon.