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Legacies of Long-term Forest Management on Dissolved Organic Matter Export and Molecular Composition in Source Water

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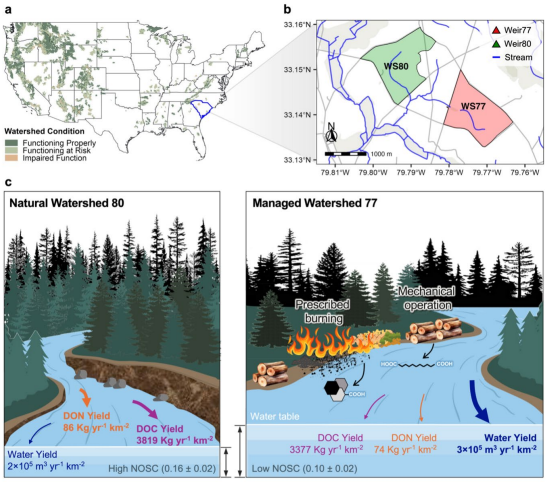

Source water quality emerges from watershed processes. Dissolved organic matter (DOM) exported from forested watersheds plays a central role in shaping aquatic ecosystems, downstream water quality, and water treatability. Forest management, including prescribed burning and mechanical operations, has long been implemented to achieve ecological and economic objectives, yet field-based evidence of how such watershed-scale disturbances affect the export and composition of DOM in source waters remains limited. Here, we report findings from a two-decade paired watershed-scale experiment in South Carolina, U.S., showing that at the landscape level, repeated forest management limited the mobilization of terrestrial DOM into streams, with increasing divergence between managed and reference watersheds; at the molecular level, both practices introduced unique molecules with low oxidation states into downstream environments. While short-term pulse effects following individual management events are transient and reversible, repeated forest management accumulates into long-term press effects that reshape both the flux, composition, and reactivity of DOM in ways that persist well beyond the duration of individual practices. Recognizing these legacies provides a scientific foundation for understanding and managing source water quality, watershed resilience, and forest ecosystem services.