Current and future river organic carbon export using discharge and constituent load data archives

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The transport of organic carbon [OC] by rivers to the coastal ocean is an important component of both the biological and geochemical carbon cycles. Human activities modify this natural system, e.g. dams that trap sediments and POC in reservoirs, land-use changes that limit infiltration, and increased carbon and nutrient runoff from agricultural practices. In the absence of Earth system and process models to describe natural-state river OC fluxes at high spatial and temporal resolution, much uncertainty remains about the current state and future predictions of river OC export. Probabilistic models drawn from long-term data archives of river discharge and constituent load provide a means to explore river OC export, in which annually-averaged and seasonal discharge and load data lead to assessment of river OC export in modern settings and under future scenarios.

We used USGS streamgage data to develop a model of discharge, sediment and OC export for a suite of northeastern USA rivers. Specifically, we constructed annual and seasonal (winter, spring, summer, fall) discharge probability density functions and constituent rating curves for TSS, POC, DOC, POC C/N ratios and POC %OC. We employed Monte Carlo simulations to recreate modern export characteristics. For example, in rivers with a strong snowmelt freshet, annual DOC, POC and TSS export are dominated by a few spring discharge events; low-frequency summer storm events are unlikely to contribute to a single year's OC export, but do impact multi-year averages. We then modeled future land-use and climate change scenarios by modifying discharge probability distributions and rating curves. Model results show significant and differing effects on the amount and timing of discharge, sediment supply and OC export in response to these forcings. For example, scenarios that reflect reduced snowpack melt and spring freshet result in increased TSS and reduced POC export, sediments with lower %OC and higher C/N ratios, and shifts in sediment and OC export from spring to winter. These results highlight an approach to assess impacts of future climate and land-use change on the amount and seasonal timing of river OC export. The results also suggest that unforeseen phenological consequences may arise in the connections of these changes with coastal ecosystems and carbon cycling.