

Multiple techniques for analyzing riverine DOC (carbon isotopes, biomarkers, mass spectrometry) can trace integrated characteristics of forest watersheds in South Korea and North Korea over 73 years.

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Riverine dissolved organic carbon (DOC) concentrations and properties reflect watershed characteristics, and therefore present a unique opportunity to compare and contrast watersheds under distinctly different management regimes in South Korea and North Korea after 1948 when South Korea and North Korea were divided. We collected river water samples from June 2020 to July 2021 in adjacent forest watersheds in South and North Korea to compare riverine DOC in the South (S1 & S2) and North (N1 & N2) Korean watersheds. The watersheds were categorized as large (S1: 2,080, N1: 3,131 km²) or small (S2: 8, N2: 262 km²) by watershed area. We analyzed DOC concentration ([DOC]) and characteristics including dual carbon isotope ratios, lignin phenols, and molecular composition by Fourier transform-ion cyclotron resonance mass spectrometry (FT-ICR MS). Although [DOC] of S1 river was higher at 1.7 mg L⁻¹, riverine [DOC] was low in the other watersheds (~1.0 mg L⁻¹), which are typical riverine [DOC] found in forests in South Korea, reflecting forest dominance (>76.5%) within the watersheds. Although [DOC] were similar among the four rivers, ¹⁴C ages were strikingly different. The ¹⁴C age of DOC was 683 years before present (YBP) in N1 in contrast to the others (85 YBP (S1) to modern (N2 & S2)). The stable carbon isotope ratio also demonstrated a difference between N1 and the other rivers. The $\delta^{13}\text{C}$ -DOC was -16.7‰ in the N1 river in contrast to -22.0 – -29.0‰ in the others, reflecting DOC derived from C4 plants, which presumably came from corn cultivation. The lignin phenol analysis did not reveal a clear difference in dual carbon isotope ratios between N1 and the others. However, in S2, the most forested watershed, carbon-normalized lignin phenols were higher, and the acid-to-aldehyde ratio of vanillin was lower, suggesting inputs of less degraded plant materials into river DOC. FT-ICR MS did not show significant differences in molecular formulae in riverine DOC. A multi-technique approach for analyzing riverine DOC, including isotope analysis, can trace watershed characteristics under two contrasting political regimes, which are difficult to capture by satellite images.