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Anthropogenic impacts on the optical characteristics and biodegradability of dissolved and particulate organic matter in the Han River watershed, South Korea

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To understand how anthropogenic perturbations such as dams and pollution modify the chemical characteristics and biological transformations of riverine organic matter during transit through urbanized watersheds, we compared the optical characteristics and biodegradability of dissolved organic matter (DOM) and particulate organic matter (POM) along different reaches and urban tributary streams of the Han River watershed during short-term incubations. Laboratory incubations were conducted for 5-7 days at 20-25 ^{o}C with filtered or unfiltered water samples collected from up-, mid-, and downstream reaches with different levels of anthropogenic perturbations and three urban streams along the downstream reach that receive effluents from waste water treatment facilities in the metropolitan Seoul. Optical parameters such as ultraviolet absorbance at 254 nm, absorption coefficients at 254 nm and 350 nm, fluorescence index, humic-like fluorescence, microbial humic-like fluorescence, and protein-like fluorescence, and spectral slope at 350-400 nm were significantly correlated with increasing concentration of biodegradable dissolved organic carbon (BDOC) in filtered and unfiltered sample along the Han River up-, mid-, down-, and urban streams. The concentrations of BDOC in the urban streams were 6-12 times higher than in the filtered and unfiltered main-stem river samples, with significantly higher values in presence of POM in the unfiltered samples than in the filtered samples. In a separate 5-day incubation experiment with the unfiltered water sample from a downstream location of the Han River and its urban tributary water in isolation or mixed , the rate of concurrent biodegradation of both DOM and POM, as measured by the cumulative rate of CO_2 production, was higher in the mixture than the average rate of the separately incubated samples, indicating the priming effect of mixed organic materials on the biodegradation of allochthonous organic materials from the other site. Greater amounts of CO_2 were produced in all the samples than could be explained by BDOC alone, indicating the role of POM as a source of CO_2. Faster and more intense changes in the consumed or produced components detected in the differential images between the fluorescence excitation emission matrices collected at intervals also suggested activated organic matter processing and CO_2 production upon mixing the mainstem and tributary organic matter. Overall results suggest that dams and urban water pollution leave idiosyncratic imprints in the optical characteristics of DOM along waterways of the dammed and urbanized watershed and that inputs of anthropogenic organic materials via urban tributary streams can exert a strong priming effect on the biodegradation of both DOM and POM downstream.