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A probabilistic framework for nutrient uptake length

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The nutrient uptake length, the average displacement of a nutrient in a stream before being taken up by the biota, is an important quantity to characterize and compare streams and rivers, or to quantify certain aspects of their related ecosystems. This concept has been widely used for almost thirty years now, and uptake lengths have been estimated for several nutrients in many systems, but it also suffers from a number of limitations, one of them being the requirement of a spatially homogeneous stream or river. We combine recently advocated, transport-based models of stream processes with current concepts of dispersal theory into a novel framework for nutrient uptake length. The framework is based on the theory for dispersal kernels in terrestrial systems, where the entire distribution of dispersal distances is calculated and not only the average. Within this framework, we can re-derive all previous results and formulae for uptake length, and we can include spatially heterogeneous stream environments. In addition, we propose a number of new characteristic quantities that can complement nutrient uptake length when evaluating the health of a stream system or the impact of a source of nutrients.

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