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Constituent Loads in Small Streams: The Process and Problems of Estimating Sediment Flux

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Constituent loads in small streams are often estimated poorly. This is especially true for discharge-related constituents like sediment, since their flux is highly variable and mainly occurs during infrequent high-flow events. One reason for low-quality estimates is that most prevailing data collection methods ignore sampling probabilities and only partly account for variations in constituent flow. Such "nonstatistical" methods are often biased and can perform unpredictably in different circumstances. In contrast, "statistical" methods --which require additional effort to ensure random sampling--are unbiased, have wide application, give valid error estimates, and can use characteristics of sampled populations to control sample size. Such concepts and properties are not merely theoretical; they can have important effects on engineering works and research results. Errors in estimating sediment loads come from several sources: population definition, calibration, sampling, and measurement. The sources of error get little attention in most load estimating projects, but should play a central role to obtain accurate and precise estimates. Constituent load estimation should be thought of as a process, much like a natural process, but one we can control. The process begins with planning, includes data collection, and ends with analysis; all parts must be addressed to obtain results that perform with the planned accuracy and precision. Hydrological data-collection technology intrinsically affects the operation of the estimating process. Pumping samplers have changed the way sediment data are measured and sampled and field microprocessors are doing the same. New technology should be consciously incorporated into the estimating process to capitalize on any unique characteristics. Increased use of more sophisticated instrumentation, however, requires more highly trained field personnel.