A validation of the cumulative watershed effects models: Delta-Q and FOREST

S.E. Litschert and L. H. MacDonald,
College of Natural Resources, Colorado State University

Abstract. Cumulative watershed effects (CWEs), such as the hydrologic and sedimentary changes due to management activities, are a critical and legally required concern for many land managers. Our goal is to develop a suite of GIS-based models for assessing CWEs in forested watersheds that are easy-to-use, spatially and temporally explicit, and scientifically based. Delta-Q and FOREST (FORest Erosion Simulation Tools) are a series of empirical and conceptual models that calculate the annual changes in discharge (Delta-Q) and annual sediment production, delivery and yield (FOREST) from roads, fires, and forest management. This paper reports on the initial effort to validate Delta-Q and FOREST using data from the Caspar Creek experimental watersheds in northwestern California.

In the South Fork Watershed (424 ha) selective harvests removed 65% of the timber from 1970-1972. Portions of the North Fork Watershed (473 ha) at Caspar Creek were successively clearcut in 1985 (12%), 1989 (11%), 1990 (15%), and 1991 (11%). To validate Delta-Q, we compared predicted annual values for the 1st, 50th, and 99th percentile flows on the North Fork Watershed against the values calculated from daily streamflow data for 1990-2004. To validate FOREST we compared: 1) predicted and measured annual suspended sediment yields and 2) predicted bedload yields against the measured sediment yields from weir ponds. These comparisons were made for each year from 1963 to 2004 for both the North and South Fork watersheds.

The interannual climatic variability in flow percentiles and sediment yields was often greater than the effects of forest harvest and this made validation difficult since Delta-Q and FOREST predict the annual response to management independent of climatic variations. Hence the predicted and measured 50th percentile flows were closer than the 1st and 99th percentiles, as the more extreme flows are more sensitive to climatic fluctuations. While predicted bedload sediment yields usually fell within the range of measured values, suspended sediment yields were generally overpredicted. These results suggest that the models may be particularly useful because of their ability to: estimate the varying changes in specific flow percentiles; generate GIS layers to show the spatial distribution of sediment production and delivery over time; to show which stream reaches have the greatest risk for sedimentation; and to show explicitly how changing the rate of recovery affects the magnitude of the predicted CWEs.