

## **Landslide volumes and estimated landslide sediment delivery to streams in the central Sierra Nevada, California.**

Nancy E. Brown

Ph.D. candidate, Department of Earth Resources, Colorado State University. E-mail: [brune@cnr.colostate.edu](mailto:brune@cnr.colostate.edu)

**Abstract.** A field-based landslide survey was conducted in a 1,200 km<sup>2</sup> study area on the west slope of the central Sierra Nevada in California. Survey objectives were to estimate recent landslide sediment delivery to streams and evaluate the effects of geology, streams and roads on landsliding. Over 100 landslides were measured on 1-kilometer segments totaling 10.5 km along streams and 13 km along roads. Additional 2- to 4-kilometer-long segments, totaling 31 km, were surveyed to increase the survey coverage of larger slides.

The volume of sediment delivered to streams is difficult to estimate in part because of uncertainty about the complete size-frequency distribution of landslides. In the study area, most observed landslides are shallow in depth, occur predominantly in colluvium or alluvium rather than bedrock, and are debris slides or shallow rotational failures. The predominance of shallow slides results from depth limitations imposed by strong bedrock at shallow depths and the frequency of low cohesion sandy colluvium formed from granitic bedrock. For these shallow slides, depth to the failure plane increases more slowly with slide area than it would for constant landslide form. This means that smaller slides form a larger proportion of the landslide sediment than if constant form was maintained over the range of landslide sizes.

The average rate of sediment delivery to streams can be approximated as the rate of sediment evacuation from landslide sites, where evacuation is the difference between landslide void volume and deposit volume. Average delivery rates were estimated first from evacuated volume in the full dataset divided by the approximate time base of 150 years. Average rates were also estimated from a reduced set of slides field dated as 30 years old or less. For streamside landslides, there is little space for storage, and equating sediment evacuation to delivery appears to be a good approximation. For landslides on uplands, unrecognized storage on hillslopes could be large, and this approach may overestimate delivery.

Estimated delivery of landslide sediment delivery to streams is 2 to 10 mm/ka, or about 3 to 15 t/km<sup>2</sup>-yr. The maximum of these delivery rates approximately equals the lowest estimates of hillslope erosion rates in the Sierra Nevada reported in a published cosmogenic isotope study (Riebe and others, *Geology*, 2000). A comparison of the results of this survey to a previous landslide inventory in the study area based on aerial photographs indicates that larger slides may be under-represented in the current study, and that sediment delivery from landslides may be 2 to 3 times these estimates. Streamside landslides are about 15 to 30 percent of the delivered volume estimated in this study. Road-dependent landslide volumes are about 4 percent, and road-related slides may be 85 percent, of the non-stream delivered volume.