Measuring sediment production from natural hill-slopes and disturbed surfaces in a dry tropical setting- La Parguera, Puerto Rico

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Abstract. The coral reefs of Puerto Rico are threatened by land-based sources of pollution, and the US Coral Reef Task Force has recommended the immediate development of local action strategies to mitigate those threats. Anecdotal and indirect evidence suggest that sediments derived from land development activities are among the top pollutants affecting the coral reefs of Puerto Rico, but limited empirical information is available on upland erosion, particularly for dry tropical areas. This study addresses the need for empirical sediment production data by quantifying the effects of land development on hillslope-scale sediment production in the La Parguera area of southwestern Puerto Rico. Sediment production rates were measured from 12 undisturbed hillslopes, 11 cutslopes, and 9 unpaved road segments between July 2003 and June 2005, yielding a total of 136 measurements. Cutslope gradients ranged between 70 and 130 percent, while gradients for road segments and undisturbed hillslopes ranged between 1 and 30 percent. None of the road segments have experienced any significant traffic or maintenance activity since 1999. Runoff and sediment yields were also measured from three bounded plots (3 m2) on freshly disturbed road surfaces between July 2004 and May 2005.

The mean sediment production rate from undisturbed hillslopes was 0.2 Mg ha-1 yr-1 (0.001 to 1.4 Mg ha-1 yr-1 range), and this is one-order of magnitude higher than the mean rate measured from a similar dry tropical setting on St. John in the U.S. Virgin Islands. The difference may be attributed to a lower vegetation density in La Parguera. At a mean sediment production rate of 9 Mg ha-1 yr-1 cutslopes had the highest erosion rate among the three measured surface types. Sediment production from natural hillslopes and cutslopes were poorly correlated with average gradient, but generally well correlated with total rainfall.

Measured sediment production rates from road segments averaged 2 Mg ha-1 yr-1 with a 0.05 to 6 Mg ha-1 yr-1 range, and these rates imply a one-order increase in sediment production rates above background rates. Sediment production rates from road segments were poorly correlated with rainfall, but well correlated with average gradient. The poor correlation with rainfall is due to an observed exponential decrease in sediment production rates through time, presumably caused by the progressive increase in vegetation cover density throughout the study period. The observed road segment erosion rates in La Parguera are about two- to four-orders of magnitude lower than measured rates from actively-used roads on St. John. The lower rates observed for the La Parguera road segments are likely due a higher vegetation cover density, the presence of a well-armored surface, and the lack of traffic and grading.

Limited data from 3m2 runoff plots on freshly-disturbed road surfaces suggest that sediment production rates immediately following disturbance range between 3 and 12 Mg ha-1 yr-1, and these rates are within the lower end of those measured from actively-used roads in St. John. Additional field data collection is scheduled to continue from 2006 to 2007 to better quantify sediment production rates from freshly-disturbed surfaces. The data collected by this study will be used to improve empirical sediment production functions used by a GIS-based erosion model (STJ-EROS) to estimate sediment yield rates from the La Parguera area and other coastal watersheds of the Eastern Caribbean.

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