Long-Term Erosion and Sedimentation Rates of the Rió Chagres Basin Based on Cosmogenic ^{10}Be

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ABSTRACT

The continuous and predictable operation of the Panama Canal has been of local and global interest since its construction. Critical to the performance of the canal is a steady supply of water from the Rió Chagres watershed to Lake Alhajuela, the main reservoir that stores and supplies water during dry years. Vital to the utility of the reservoir is the water storage capacity of Lake Alhajuela, which can decrease due to sedimentation. Riós Chagres, Pequení, and Boquerón are the three main tributaries that supply sediment to Lake Alhajuela. The Pequení and Boquerón watersheds are significantly altered by farming and presently have suspended-sediment loads that are two to three fold higher than the sediment yield from the mostly undisturbed Chagres watershed. Although sediment yield data have been collected since 1981, these data may not be representative of the long-term sediment yield from the Chagres watershed.

In situ- produced cosmogenic ^{10}Be was measured in 24 sediment samples to estimate the background (20,000 yr) sediment yield from the upper Chagres watershed. Sediment samples were collected from 7 small tributary watersheds (<10 km^2) to determine the background nuclide activity of sediment eroded from the steep hillslopes. Sediment samples were collected from the confluence of three major tributaries (Riós Chico, Piedras, and Chagricito) to determine the average nuclide activity of the main stem Chagres, each major tributary, and the mixed sediment below the confluence. A sample was collected on the first point bar upstream of Lake Alhajuela to determine the average basin-wide erosion rate of the entire watershed. Seven analyses for gravel size sediment (> 0.9 cm) were replicated to investigate the variance of nuclide activities for different grain sizes.

Preliminary results from 17 sand size samples (0.25 to 0.85 mm) suggest that the Chagres watershed is eroding uniformly. Small tributary basins have a wide range of nuclide activities and thus basin-wide erosion rates (54 to 134 mm ky^{-1}; average = 92 ± 22 mm ky^{-1}). The range in basin-wide erosion rates decreases significantly for the large tributary basins (84 to 100 mm ky^{-1}; average = 99 ± 22 mm ky^{-1}). The basin-wide erosion rate based on the sample collected on the first upstream point bar from Lake Alhajuela suggests a basin-wide erosion rate of 102 ± 23 mm ky^{-1}. These three independent estimates of long-term basin-wide erosion rates suggest that the Chagres basin (when considered on scales <10 km^2 to > 350 km^2) is eroding on average between 90 and 100 mm ky^{-1}. These erosion rate estimates are similar to the basin-wide erosion rates calculated from suspended sediment yield from 1981 to 1996 (108 mm ky^{-1}).

All 7 gravel size samples (> 9 mm) have significantly lower nuclide activities than the sand size samples for each location. Where human disturbance and topographic relief is low, the average erosion rates of the gravel samples are similar to the sand-sized erosion rates assuming the gravel was eroded from local core-stones (lower nuclide production rate). In basins of where there has been significant disturbance (Piedras watershed) the gravel-sized sediment samples are consistent with higher frequency of landsliding or deep gullying (lower nuclide production rates at depth) caused by clear-cutting. Therefore, nuclide activities of sand-sized samples are representative of average long-term erosion rates, while nuclide activities of gravel-sized sediment highlight local core-stone erosion or increased rates of mass wasting.