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Patterns and contributions of floodplain and legacy sediments remobilized from Piedmont streams of the mid-Atlantic U.S.

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The perceived role of streambank erosion as a contributor to watershed sediment yield is an important driver of policy decisions for managing downstream impacts in the United States. In the Piedmont physiographic province of the eastern U.S. and in other regions of the south and midwest, the issue of "legacy" sediment stored in stream valleys has long been recognized as a consequence of rapid deforestation and erosive agricultural practices following European settlement. Remobilization of stored floodplain sediment by bank erosion is frequently cited as a dominant component of watershed sediment budgets, with legacy sediment comprising the largest portion of this source. However there are few published studies documenting spatially extensive measurements of channel change throughout the drainage network on time scales of more than a few years. In this study we document 1) rates of sediment remobilization from Baltimore County floodplains by channel migration and bank erosion, 2) proportions of streambank sediment derived from legacy deposits, and 3) potential contribution of net streambank erosion and legacy sediments to downstream sediment yield within the Mid-Atlantic Piedmont. We measured gross erosion and channel deposition rates over 45 years within the fluvial corridor along 40 valley segments from 18 watersheds with drainage areas between 0.18 and 155 km^2 by comparing stream channel and floodplain morphology from LiDAR-based digital elevation data collected in 2005 with channel positions recorded on 1:2400-scale topographic maps from 1959-1961. Results were extrapolated to estimate contributions to watershed sediment yield from 1005 km^2 of northern Baltimore County.

Results indicate that legacy sediment is a dominant component (62%) of the sediment derived from bank erosion and that its relative importance is greater in larger valleys with broader valley floors and lower gradients. Although mass of sediment remobilized per unit channel length is greater in these downstream valleys, a majority of remobilized sediment (62%) is coming from first- and second-order tributaries because they represent the largest fraction of cumulative channel length in the drainage network. Floodplain segments are discontinuous along low-order tributaries but sediment contributions reported here are adjusted to account for the percent valley length bordered by floodplain sediments. Average annual lateral migration rates ranged from 0.04-0.19 m/y with higher rates along larger streams; however, when scaled by channel width, we find that on average streams are migrating 2.5% of channel width across all drainage areas.

Direct measurements reported here account for in-channel deposition, but not floodplain deposition. Other studies in the region have demonstrated that redeposition on floodplains is an important component of the sediment budget and are necessary to avoid overestimating streambank erosion contributions to watershed sediment yield. We therefore adjust our measured sediment contributions by estimating the mass of sediment redeposited on floodplains within our study area. With this adjustment, extrapolated net stream bank sediment yields (72 $Mg/km^2/yr$) are equivalent to 70% of the estimated average Piedmont watershed yield (104 $Mg/km^2/yr$) cited by previous authors. Furthermore, our results demonstrate that measurements over adequate spatial and temporal scales- rather than short-term, localized observations- are required to accurately capture and measure patterns of streambank erosion across the drainage network. It is important to note that upland erosion rates- not measured here- have been reported with equivalent and greater magnitude for forested and cropland areas within the Maryland Piedmont and therefore should not be assumed to contribute only 30% of the total.