Mechanics of Sediment Plug Formation in the Middle Rio Grande, NM

Kiyoung Park and Pierre Y. Julien
Department of Civil Engineering, Colorado State University, Fort Collins CO 80523

Abstract. Sediment plugs have occurred 4 times over the last 20 years in the Middle Rio Grande, NM. Starting in the Tiffany area in 1991~1995, and 2005, a sediment plug occurred around the Bosque del Apache Wildlife Refuge in 2008. In order to examine the mechanics of sediment plug formation, analytical and numerical modeling approaches have been adopted. Analytical relationships show that sediment transport capacity is inversely proportional to the channel widths as $Q_{sr} = W_r^{-0.2}$. The Rouse number ranged from 0.6 to 1.7 for 10 sub-reaches, showing that near–surface sediment concentrations are very small compared to the near-bed concentrations. At the locations where sediment plugs occurred, the Rouse numbers were larger, thus resulting in near-surface water clearer than neighboring cross sections. Therefore, the variability of channel widths (-60%~120%) caused overbank flows (13~20% between San Acacia Gauge and San Marcial Gauge), and a disproportionately low sediment loss(less than 3%) to overbank areas caused the channel bed aggradation in the main channel. A 1-D numerical model was developed and simulated for the 1995 Tiffany plug and the 2008 Bosque plug, showing good agreement with analytical results. At the locations where sediment plugs formed, aggradation was due to wider channels, shallow bank crest, and significant overbank flows. These factors caused the conveyance capacities between channel bed and the bank crest (1.6~4ft) to be filled with sediments within less than a couple of weeks. The numerical results show that the vertical distribution in sediment concentration accelerates the rate of aggradation by an order of magnitude. For high Rouse number (Ro>1.2), aggradation rates were 7 times faster than for uniform concentration profile. Therefore, sediment plugs may occur again when overbank flows, loss of sediment transport capacity, and non-uniform concentration distributions are happening at the same time.