Sustainable channel width analysis for the Middle Rio Grande, NM

Kiyoung Park and Pierre Y. Julien
Department of Civil and Environmental Engineering, Colorado State University

Abstract. Sediment plugs have occurred four times in the last 20 years near Bosque del Apache of the Middle Rio Grande, NM. For optimizing the sediment transport rate and reducing the likelihood of sediment plug formation, a sustainable channel width analysis was performed using analytical and numerical approaches. For these analyses, channel conditions in 1992 and 2002 were used; bank-full discharge (commonly 5,000cfs), channel slope (0.0007-0.00073), sediment size (0.2-0.25mm), various channel widths (131-5,183ft). Analytical relationships between width, width-depth and sediment discharge were derived by using 3 basic equations: continuity, Manning's flow resistance, and Julien's sediment discharge equation. The relationships show a maximum sediment transport capacity when the width-depth ratio equals 18, which corresponds to a channel width of 130ft. At larger channel widths, the sediment transport capacity decreases as $Q_{sr} = {W_r}^{-0.2}$, where W_r is the width ratio and Q_{sr} is the sediment discharge ratio. Numerical results using Yang's sediment transport equation show that the maximum sediment transport capacity occurred when the width-depth ratio is 1.5 and the width is 31ft. For channel widths ranging from 131 ~ 5,183ft and depths from 1.6 to 6.9ft (width/depth ratio 28~2,860), increasing the channel width would lead to a decrease the sediment transport capacity and induce sedimentation in this channel. In addition, numerical simulations for the 1992 and 2002 channel conditions based on the program of Leon et al. (2009) showed that wide sub-reaches have smaller sediment transport capacity, causing aggradation of the channel bed. Therefore a narrow and deep channel is expected to reduce the likelihood of sediment plug formation.