Use of the Manning Equation for Predicting the Discharge of High-Gradient Canals and Natural Streams

Nicholas D. Udy, Steven H. Emerman, Ashley A. Ostraff, Sarah M. Allen, Henintsoa Rakotoarisaona, Janelle Gherasim, Alison M. Stallings, Jeremy N. Saldivar, Kenneth L. Larsen, and Morgan Abbott
Department of Earth Science, Utah Valley University, Orem, Utah

Abstract. The Manning Equation is used to predict stream or canal discharge from hydraulic radius, slope of the water surface, and a Manning roughness coefficient. Jarrett (1984) proposed that, for high-gradient streams ($S > 0.002$), the Manning roughness coefficient could be predicted from the hydraulic radius and the slope alone. The objective of this study was to develop separate empirical formulae, depending upon climate and stream bank lithology, for predicting the Manning roughness coefficient for high-gradient canals and natural streams from hydraulic radius and slope. The objective was addressed by separating the database used by Jarrett (1984) according to stream bank lithology, and by carrying out new measurements of the Manning roughness coefficient at nine high-gradient stream sites with crystalline (igneous and metamorphic) banks and two high-gradient stream sites with carbonate banks in Haiti, nine high-gradient stream sites with carbonate banks in Utah, and 14 high-gradient canals in Utah. The data were used to develop empirical formulae for predicting the Manning roughness coefficient for (1) continental climate, clastic stream bank (2) tropical climate, crystalline stream bank (3) continental/tropical climate, carbonate stream bank (4) continental climate, earthen canal with grassy bank. The Manning roughness coefficient was a negative function of hydraulic radius for the first case and a positive function for the other cases, suggesting that the increase in turbulent resistance is caused by the roughness of the sediment in the first case, but by the increase in the Reynolds number, which is proportional to the depth, in the other cases.