

Sediment Wave Propagation Modeling in the Doce River after the Fundão Tailings Dam Break in Brazil

Marcos C. Palu¹ and Pierre Y. Julien²

Department of Civil and Environmental Engineering, Colorado State University

Abstract. On November 5 of 2015, the collapse of the Fundão Tailings Dam located in the Doce River Watershed in Brazil caused the destruction of the Bento Rodrigues Town, resulting in 19 casualties. Furthermore, the propagation of an estimated 32 millions of cubic meters of mud caused the interruption of water supply in 12 cities affecting 424,000 people. The immediately damage in the environment was the death of nearly 3 tons of fish. After the dam break, the floodwave traveled 100 km through the Gualaxo do Norte and Carmo Rivers until the Doce River. Approximately 27 million cubic meters of hyperconcentrated sediment deposited in this reach and approximately 5 million cubic meters reached the Doce River. The Geologic Service of Brazil and the National Water Agency conducted measurements to keep track of the wave propagation and the sediment concentration along the 650 km of Doce River until the wave reached the Atlantic Ocean. A finite difference modeling using the Crank Nicolson scheme was coded in Matlab to simulate the floodwave propagation, considering the diffusive wave approximation for the Saint Venant Equation. In addition, the analytical solution of the advection-dispersion equation using the complementary error function was successfully applied for the transport of suspended sediment. Both models are in good agreement with the observed flow and sediment concentration along the Doce River. Finally, the analysis of the observed data highlights the difference between the celerity of the wave propagation and the velocity of the sediment along the river. As noticed, the floodwave reached the ocean 16 days before the sediment. This effect gave rise to the counterclockwise hysteresis curve, where the peak sediment concentration lags behind the peak discharge.

¹ Ph.D. Student, Department of Civil and Environmental Engineering, Colorado State University, Fort Collins, CO, 80523-1372, marcos.palu@colostate.edu

² Professor, Professional Engineer, Department of Civil and Environmental Engineering, Colorado State University, Fort Collins, CO, 80523-1372, pierre@engr.colostate.edu