Application of GSTARS3 to Xiaolangdi Reservoir Sedimentation Studies

Chih Ted Yang and Jungkyu Ahn
Department of Civil and Environmental Engineering, Colorado State University

Abstract. Xiaolangdi Reservoir is located at 40km north of Loyang and 128km downstream of the Xiamenxia Reservoir on the main stem of the Yellow River. It is well known that sediment concentration is very high in the Yellow River. Due to high sediment load, Xiaolangdi Reservoir should be operated with yearly draw down sluicing to reduce sedimentation in the reservoir. GSTARS3 computer model is used in this study to simulate the sluicing and sedimentation processes of the Xiaolangdi Reservoir. Xiaolangdi Reservoir has more than 40 tributaries coming into the reservoir. The inflow from each tributary is small compared to the inflow from upstream. However, the total volume of these tributaries is about 40% of the total reservoir volume. The effects of tributary volume were considered in GSTARS3 simulation. In a drawdown process, water and sediment discharges from tributaries into the main reservoir. On the other hand, directions of water and sediment flows are reversed when water surface rises. Volume of sediment and water exchange between tributary and main reservoir were calculated. Non-equilibrium sediment transport process is used in GSTARS3 to simulate spatial and time delay effects of sediment transport. Previous studies suggested that non-equilibrium sediment transport recovery factor is related to scour and deposition processes in a reservoir as a function of location above the dam and representative bed material size, such as d_{50}. This study indicates that the variation of the recovery factor is a function of sediment size in each size fraction of the graded material. Study results indicate that the recovery factor is inversely related to a power function of sediment size of each sediment size fraction of the graded materials. In this study, sediment size is divided into nine groups and each group has a different recovery factor for the non-equilibrium sediment transport routing. Computed results from Yang's 1996 formula showed good agreements with field data collected from the Yellow River. Simulated results using GSTARS3 with Yang's 1996 formula and non-equilibrium sediment transport equation agrees well with surveyed reservoir bed profiles and size distributions of the bed material.