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Esmeralda Hydropower Station Reservoir Sedimentation and Discharge Study

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In hydro power generation applications, the primary function of reservoirs is to provide storage capacity over time. The most important aspect of this design is the analysis of the relation between sediment yield over the catchment, cost management of the facility with regards to disposal or extraction of deposits and residual storage capacity to guarantee power generation and emergency reserves. If sediment inflow is large the reservoir capacity may be limited or reduced, management difficulties and interruptions occur and the useful lifespan of the reservoir may be shorten. Reservoir planning requires the correct consideration of the probable rate of sedimentation over time in order to foresee the actual life cycle of the structure and maintenance requirements. The main difficulty associated with reservoir sedimentation is the management and disposition of accumulated sediment. In the mountainous region of Colombia, sediment yield is important over the catchment and has further augmented lately through important deforestation over a large portion of the territory and urbanization. Such situation has significantly affected the operations of the Esmeralda reservoir. Built in the 1960′s, the reservoir was designed considering estimated rate of sediment production associated with the river system and involved a system of sluice gates to provide for sediment discharge away from the tank. Lately the gate system has been ineffective and accumulation of sediments in the reservoir has impaired operations appreciably. It was believed that considerable changes in the watershed had altered the sediment transport dynamics, significantly reducing the efficiency and capacity of the tank. This study investigated the flow characteristics and sediment transport processes occurring within the tank using a numerical flow model of the reservoir in order to provide for a better understanding of the minimum flow velocities through the sluice gate system and density current within the tank. Also grain size distribution was provided and considered based on the critical velocity provided by the modified Colby Method. In order to assess geomorphological changes that may have occurred, satellite imagery from 1999 to 2018 was analyzed using spectral frequency analysis generating a qualitative comparison of the changes that had occurred related to soil use and urbanization of the basin area. The study revealed that flow velocities are inappropriate to ensure the removal of the sediments currently observed within the tank and that the designed extraction system is unable to initiate the flushing process of the tank. Image analysis revealed substantial changes in land use over the last 20 years that have altered the sediment characteristics of the channel and will render the current design of the reservoir obsolete in a near future.