ABSTRACT

Reservoirs and barrage pond areas, built across alluvial rivers throughout the world, are losing their storage capacity at an estimated rate of about 0.5 to 1% annually. The pond area of Durgapur Barrage on River Damodar, India, fed by variable discharge from Panchet and Maithon dams and also controlled by barrage-gates is no exception. In spite of its service for more than 60 years through judicious gate-operation schedule, it is found that 52% of initial storage capacity of the Durgapur Barrage Pond has been lost since its inception in 1956. It has been reported that total upland sediment load transported downstream gets deposited in the barrage pond area due to the ponding effect. The present thesis highlights morpho-dynamic behavior of the Damodar River, extending from Maithon and Panchet dams at upstream to Durgapur Barrage in the downstream owing to the fluctuating discharge depending upon the rainfall pattern in the catchment areas of the dams. The analysis has been performed by means of numerical model of MIKE-11 software considering hydrometeorological and fluvial data of Damodar-Barakar River basin. Hydrodynamic and Sediment Transport models of MIKE-11 were simulated to ascertain annual rate of erosion and deposition during the period from the year 1956 to 2066. The river network has been delineated using a software (ArcGIS) from the old maps and relevant data of digital elevation model [DEM of Shuttle Radar Topographic Mission data (SRTM)]. From these maps of different years and SRTM data, a total 128 number of cross sections at 500 m intervals have been reconstructed through ArcGIS. A synthetic hydrograph, in the form of time-series discharge data, was prepared for the entire simulation period 1956 to 2016, by corelating the IMD's public domain gridded rainfall data of Damodar-Barakar basin-catchment and the measured inflow discharge in the receiving dams, Maithon and Panchet for the period 2009 – 2016.

A representative value of measured suspended sediment concentration (SSC) for different discharges throughout the year from various locations of the model domain has been calculated and utilized for sediment transport analysis. Calibration and validation of the model for both hydrodynamic and sediment transport simulation have been done using field data, collected throughout the year from various measuring stations.

Initially, it is observed that the river bed in the upstream portion (chainage 0 to 40 km) gets eroded and a significant part of these eroded material including the susceptible component of suspended load gets deposited in the lower stretch of the river (chainage 40 km to 66 km). And almost 50% of the total deposition, was deposited only within the pond area. Study reveals that about 6 MCM catchment-sediment has entered in the model domain through Dam-discharges during the year 1956 to 2016, a part of which got deposited in the river bed while the remaining 4.9 MCM sediment departed towards downstream through Barrage gates. Though the rate of sediment deposition in the barrage pond area was initially higher during the period 1956-1985 but with the passage of time it has reduced considerably. However, daily deposition increased more or less linearly with the increase in discharge of the river. The present capacity of the pond area has been reduced from 10.273 MCM to 4.843 MCM (about 47% of the initial capacity) as measured in the year 2016.

To get rid of the problem of siltation in the pond area, an alternative solution – 'sediment removal through flushing' has been examined in the model experiment and suggested for implementation. Different combination of flushing options (empty flushing and draw down flushing) with 15 days sinusoidal hydrograph and 4 days rectangular hydrograph, yearly once with 4000 Cumecs pick discharge have been tested in the model and the best possible option for capacity augmentation was identified. A comparative statement of the outcome of different options, as envisaged by the model experiment, advocated that a hybrid flushing arrangement with 4-days drawdown flushing (gate opening full) and 1-day pressurized flushing (gate

opening at 60m) for 4000 Cumec constant discharge supported with agitation dredging is the best option for giving a respite to the authority. This technique appears to be most effective in controlling sedimentation pattern in the pond area with variable discharge and may help the practicing engineers for proper management of barrage operation.