ABSTRACT

Reservoirs are important storage structures for irrigation and water supply needs of the society. Developments in catchment areas of reservoirs such as land use changes, intensive agriculture and urbanization create environmental problems for reservoirs. This includes sedimentation, loss of storage capacity, eutrophication and ability to moderate floods. Remedial measures require understanding of specific problems to ensure continued benefits of the project. In this thesis, the problem of sedimentation, water quality and the dynamics of phosphate, the key components in eutrophication in Krishnagiri Reservoir in Tamil Nadu are addressed through field investigations and analysis of primary and secondary sources of data.

The secondary data required for the study was collected from the daily records of the office of the Water Resources Organisation, Government of Tamil Nadu in the Krishnagiri Reservoir for meteorological data, inflows into the reservoir, water level and outflows from the sluices of the reservoir from 2001 to 2009. The field investigations were conducted from March 2008 to June 2009 and include weekly collection of water samples from five locations in the reservoir; entrance to inflow, reservoir proper and three outflow sluices. Water samples were analysed for pH, EC, major ions and
nutrients by Standard Methods. Data analysis was done in MS Excel and MatLab.

The sedimentation study revealed that the sediment load entering the reservoir is dominated by fine grained particles and the Gill method predicted the trap efficiency closer to the observed values than other methods in Krishnagiri Reservoir. The trap efficiency varied from 64.99 to 95.31% and the rate of sedimentation has been estimated as 0.85% per year. The useful lifespan of the reservoir has been computed as 101 years. The reservoir has lost 41.7% of the capacity in a span of 49 years. Soil erosion from parts of the catchment and agricultural development seems to be the main causes and warrant remedial measures.

The water quality study assessed the reservoir as highly eutrophic in nature. The Electrical Conductivity and water quality parameters, especially the nutrients showed the strong influence of the monsoon season. The major rainfall (74% of 1,026 mm) and inflows (923 × 10³ m³) were received during southwest (Jun – Sep) and northeast (Oct – Dec) monsoon seasons when major outflows (10,448 × 10³ m³), maximum water level (15.87 m), capacity (46,887 x 10³ m³) and water spread area (12.39 km²) were also recorded. In contrast, higher values in Electrical Conductivity (>900 µS/cm), pH (> 9.0) alkalinity (170 – 230 ppm), chlorides (230 ppm) and total hardness (319 ppm) were recorded in summer (Mar – May) season probably due to increased hydraulic residence time (55 weeks) and low inflows.
The seasonal mean concentrations of nitrate and phosphate indicated eutrophic conditions and varied widely (0 to 1.1 ppm) during different seasons. The internal phosphorus release mechanisms coupled with differential release of water masses appear to be the cause of differences noticed (p < 0.01) in the phosphate concentrations between the left main canal and right main canal during summer season. The seasonal water quality changes respond to the hydrological profile of the reservoir which alternate between stable (summer season) and transient (monsoon season) conditions due to monsoon inflows and outflow regulations.

The dynamics of phosphate, the key nutrient in eutrophication was analysed with the secondary data through mass balance modeling approach. The application of eight different mass balance models proposed in literature to the data from Krishnagiri Reservoir indicated similar responses to the influence of monsoon season with increased R values and decreasing σ values by all the methods. When the sedimentation coefficient from these eight methods were used for the prediction of phosphate concentration in the inflow, reservoir and outflows, the results show different levels of success.

A modification for phosphorus retention available in literature and a method proposed in the present study gave comparatively better results. When the TP_in, TP_res and TP_out measured in the Krishnagiri Reservoir is compared with the estimated respective TP values, a better fit of data is obtained ($R^2 = 0.70$) in the case of TP in outflow from the Reservoir, moderate fit in the case
of TP in inflow ($R^2 = 0.42$) and average in the case of Reservoir ($R^2 = 0.24$). The main causes for the prediction errors could be due to inadequate TP input budgets and many factors involved in the TP losses to sediments.

These results point to the need for accounting of the temporal hydrological variability in modeling of reservoirs for phosphate dynamics. The method used in this study of partitioning of annual hydrological series into monsoon and post monsoon gives an improved prediction of phosphate concentration. Further research in this direction is necessary to build better predictive model for Reservoirs in monsoon regions.