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Topic : Optimisation of Reservoir Systems- Case Studies of River Basins of Karnataka

Abstract

Due to the continued widening of gap between water demand and supply, rigorous planning and management of water resource is required for sustainable development. Ever increasing demands and the difficulties associated with planning new water resource systems require efficient operation of the existing systems, and also judicious development of the new ones. Hence, scientific tools should be used to assist in the planning, design and operation of water resource systems. Hence, this thesis is taken up to optimise the reservoir Systems.

The main objective of the present research is to develop optimal operating strategies for the Kabini reservoir in the Cauvery river basin in India. To put the work carried out in this thesis in context, an extensive review of relevant literature has been carried out. The research carried out in the present research can be broadly divided into three distinct parts. In the first part, a trend detection framework based on Mann-Kendall nonparametric test and parametric Z-test and t-test has been developed. Results indicated a statistically insignificant increasing trend in the average annual inflows. For winter months, the trend in inflows was found to be statistically significant. The trends in average monthly flows obtained using the parametric Z-test and t-test were in contrast to those obtained using the MK nonparametric test. This discrepancy may be attributed to the fact that the parametric tests require the flow series to be normally distributed, which was not the case for the inflows to Kabini reservoir. Therefore, the trend results obtained using the parametric test cannot be considered reliable in

comparison to those obtained using the MK nonparametric test.

In the second part of the thesis, a LINGO-based optimisation models have been developed and applied to solve both the original four reservoir problem and the modified problem. The results produced by LINGO models have been compared with those obtained by Discrete Differential Dynamic Programming (DDDP). Both the models produced identical solutions, but the LINGO model executed faster than the DDDP model. With LINGO modelling language a series of constraints can be expressed in a concise form using sets, thus simplifying the coding process. It has been demonstrated through the research carried out in the present thesis that LINGO has the potential to be applied to the operation of large reservoir systems

The third part of the thesis describes the development and application of an optimisation model based on dynamic programming (DP). A synthetic sequence of inflows based on the Thomas - Fiering model was generated in order to assist in the assessment of the water stress situation in the future. The DP model was applied to obtain optimal rule curves based on five different sets of inflows, including the synthetic sequence generated using the Thomas-Fiering model. The rule curve specifies the target reservoir levels to be maintained during different months. Depending upon the level of reliability required by the reservoir managers, an appropriate rule curve corresponding to average inflows, 50%, or 60% reliable inflows may be adopted.

The major achievements of the research presented in this thesis include (1) development of a trend-detection framework based on MK parametric test and parametric Z-test and t-test; (2) development of LINGO based models for the optimisation of multi-reservoir systems; and (3) development of generic optimisation model based on DP.