MODELLING INTEGRATED OPERATION OF MULTIPURPOSE-MULTIRESERVOIR WATER RESOURCES SYSTEMS

By

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CERTIFICATE

This is to certify that the thesis entitled, 'MODELLING INTEGRATED OPERATION OF MULTIPURPOSE-MULTIRESERVOIR WATER RESOURCES SYSTEMS' being submitted by Mr. Pankaj Kumar Bhatia to the Indian Institute of Technology,Delhi,India, for the award of the degree of DOCTOR OF PHILOSOPHY, is a record of bonafide research work carried out by him under my supervision and guidance. The thesis work, in my opinion, has reached the standard,filfilling the requirements for DOCTOR OF PHILOSOPHY degree. The research report and the results presented in this thesis have not been submitted, in part or in full, to any other University or Institute, for the award of any degre or diploma.

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CONTENTS

ABSTRACT

This thesis aims at developing a computationally efficient methodology for modelling and analysis of integrated operation of multipurpose-multireservoir systems under deterministic and stochastic hydrologic conditions, and to demonstrate the applicability of the proposed approach. In the present study, the medium range release scheduling problems have been tackled.

Initially, a general introduction to the problem, with an overview of different modelling strategies, various issues and the research methodology to achieve objectives of the study are given. Some of the important issues tackled in the study include integrated operation of reservoirs, explicit consideration of streamflow stochasticity and environmental enhancement. A review of the literature is reported, and it is attempted to present the growth of the subject in chronological order. It is observed that high dimensionality of the problems due to increase in number of reservoirs and/or explicit consideration of streamflow stochasticity pose a challenge to most of the existing deterministic and stochastic techniques for the problem solution on available computers.

The new concepts of Lumped to Discrete Programming (LDP), based on the Progressive Optimality algorithm, and the constrained stochastic optimization including problem decomposition have been introduced. The former achieves computational efficiency by allocating, in bulk, the available water as per need to different periods through lumping all the periods of operation year into two or three intervals to be ultimately

discretized to actual number of operating periods. This approach has been validated by applying to two systems (a four reservoir and a ten reservoir) already handled in literature by other approaches.

The stochasticity of natural streamflows, treating flows as lag-1 Markov process, has been considered through a constrained approach. For a particular reliability level of operating the system nine flows, three each corresponding to availabilities of more than, equal to, and less than the reliability level, have been considered. It leads to reduction in computational requirements. The approach would be useful both at the design and operation stages.

The proposed LDP approach in conjunction with that of release/state adjustments has been used, assuming a strong cross correlation between flows at different reservoir sites. A hypothetical multipurpose-multireservoir system serving seven agriculture zones has been modelled and analyzed using realistic data. The model has been validated with the objective function of maximizing annual energy generation for deterministic and stochastic hydrology conditions. The effect of change in starting/ending storages, power plant capacities, cropping patterns, irrigation levels, irrigation targets, irrigation pattern, and reliabilities of operating the system on release policies and system benefits has been studied for the hypothetical system under consideration.

The approach being successive approximation does not require an exponential increase of computation time and the core storage. It can handle high dimensional linear and nonlinear problems on present day computers, can also explicitly consider streamflow stochasticity in the optimization.

The limitations of the study are pointed out and possible areas for future research are identified.

At the end of the text the list of references is provided followed by appendices.