Publications

TR-145

Evaluation of Storage Reallocation and Related Strategies for Optimizing Reservoir System Operations

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- Full Text

Statement of the Problem

Rapid population and economic growth combined with depleting groundwater reserves are resulting in ever increasing demands on surface water resources in Texas, as well as elsewhere. The climate of the state is characterized by extremes of floods and droughts. Reservoirs are necessary to control and utilize the highly variable streamflow. Due to a number of economic, environmental, institutional, and political considerations, construction of new reservoir projects is much more difficult now than in the past. Consequently, optimizing the beneficial use of existing reservoirs is becoming increasingly more important.

Reservoir operation is based on the conflicting objectives of maximizing the amount of water available for conservation purposes and maximizing the amount of empty space available for storing future flood waters to reduce downstream damages. Common practice is to operate a reservoir for either flood control only, conservation only, or a combination of flood control and conservation with separate pools designated for each. The conservation and flood control pools, or vertical zones, in a multipurpose project are fixed by a designated top of conservation (bottom of flood control) pool elevation. Conservation pools may be shared by various purposes, such as water supply, hydroelectric power, and recreation, which involve both complementary and conflicting interactions.

Public needs and objectives and numerous factors affecting reservoir operation change over time. An increasing necessity to use limited storage capacity as effectively as possible warrants periodic re-evaluations of operating policies. Reallocation of storage capacity between purposes represents a general strategy for optimizing the beneficial use of limited storage capacity in response to changing needs and conditions. A storage reallocation between flood control and conservation purposes typically involves a permanent or seasonal change in the

designated top of conservation pool elevation. Reallocations between conservation purposes can be achieved by various modifications of operating policies. Although given relatively little consideration in the past, storage reallocations will likely be proposed more frequently as demands on limited resources increase.

Scope of Study

This report documents an investigation of: (1) the potential of storage capacity reallocation and other related modifications in operating policies as management strategies for optimizing the beneficial use of existing reservoirs in Texas and (2) modeling capabilities for formulating and evaluating such changes to operating policies. In general, storage reallocations can involve a variety of types of reservoir use. The present study focused primarily on flood control and water supply. Multiple purpose reservoir operations involving hydroelectric power were also investigated. Both permanent conversion of storage capacity between purposes and seasonal rule curve operations were addressed. Buffer pool operations were also considered. Multiple reservoir system operation was a major emphasis of the study.

The literature was reviewed and several reservoir management agencies contacted to (1) identify experiences in studying and/or implementing storage reallocations and (2) evaluate the state-of-the-art of associated modeling and analysis capabilities.

The feasibility of seasonal rule curve operation depends upon the seasonal characteristics of the various factors affecting reservoir operation. Precipitation, streamflow, reservoir evaporation, water demands, and reservoir storage content data for Texas were analyzed to identify seasonal characteristics.

A 12-reservoir system operated by the U.S. Army Corps of Engineers and Brazos River Authority provided a case study for evaluating the potential for storage reallocations and related operating strategies. This system, located in the Brazos River Basin, is considered representative of major reservoirs in Texas. The existing operating policies and possible modifications were investigated.

The case study includes (1) flood control storage frequency and conservation drawdown frequency analyses based on the results of monthly hydrologic period-of-record simulations of reservoir system operations and (2) firm yield and reliability analyses. The generalized computer programs HEC-3, HEC-5, STATS, and MOSS-IV, and several utility software packages were used in the modeling study. Simulation of reservoir system operations was based on an 85-year sequence of monthly hydrologic data.

The case study provides a preliminary assessment of the viability of permanent storage conversions and/or adoption of seasonal rule curve operations as potential reservoir management strategies. The objective is to evaluate storage reallocation potentialities in general, not develop detailed reallocation plans. The case study is basically a reconnaissance-level hydrologic analysis of reservoir operations. The monthly period-of-record simulations provide a reasonably precise analysis of water supply considerations. However, the daily hydrologic data required for detailed analysis of flood control operations were not included in the study.

Reallocation of reservoir storage capacity involves complex institutional, financial, economic, legal, political, and technical considerations not addressed in the case study. However, the hydrologic analyses provide a good starting

point for determining what types of reallocation strategies and modeling approaches might be potentially effective and whether more detailed studies are worthwhile.

Organization of the Report

Chapter 2 is a general discussion of reservoir operation and institutional and technical aspects of storage reallocation and a review of reallocations which have been implemented or proposed throughout the nation. Chapter 3 addresses the seasonality of the hydrologic factors pertinent to seasonal rule curve operation in Texas. Chapter 4 reviews state-of-the-art modeling capabilities and describes the computer models adopted for use in the case study. The Brazos River Basin case study is presented in chapters 5 through 8. Study results are summarized, and conclusions are presented in chapter 9.

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