Mathematical Programming for Optimal Design of Multireservoir Systems

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Abstract

Water reservoir design, which is meant as evaluation of the minimum needed reservoir capacity, planned to meet a safe yield, has been an old issue in water resources systems analysis. Construction of surface water reservoirs, besides being very costly, causes numerous environmental degradations. Therefore, optimal design of the reservoirs, especially in a multireservoir system, due to presence of more complexities, is of great importance. This paper presents a mathematical (mixed-integer) programming model for optimal design of multireservoir systems. The criterion applied in the programming is reliability of water supply, which is the basic criterion concerning performance of a water reservoir. Application of the proposed model has been examined for a multireservoir problem. Results of programming show optimal capacity of each reservoir.

Keywords: Mathematical programming, Multireservoir system, Reservoir design.

1. INTRODUCTION

In the context of water resources systems analysis, optimal reservoir management and design are two old issues. In fact, reservoir management is related to a state in which the reservoir is already designed and therefore the capacity of the reservoir is known. In such problems, major challenge is to prescribe of operation policies. In other words, the challenge of such problems is to determine that how much water must be released in each time period of planning horizon. But, in design problems, capacity of reservoir is previously unknown. Hence, the main purpose of reservoir design programming models is to evaluate amount of the minimum needed capacity of reservoir, to be constructed. In fact, in such problems, capacity of reservoir, with the consideration of expected yield, and performance level is specified. In this regard, many optimization programming models have been presented in the literature. Of the oldest and most famous presented optimization programming models, are the chance-constrained models [1-15], which their primary design criterion is reliability of water supply. This type of models have been criticized [14, 15] because of their overestimation property. Also applying these models needs fitting a probability distribution to inflows of reservoir. The new presented model, in terms of reliability, is to some extent similar to chance-constrained models. In fact, both the chance-constrained and the presented model consider reliability as the primary design criterion. However, this paper aims to present a mathematical programming optimization model that could be utilized for a variety of multireservoir problems with various conditions, and does not need fitting any probability distribution. In fact randomly generated or historical inflows could be applied.

2. MULTIRESERVOIR PROBLEM

A hypothetical multireservoir problem with a schematic according to Fig.1 has been considered for modeling. As it is evident in this figure, three reservoirs are to be designed in this system. The reservoirs *a*, *b* are serial, parallel to reservoir *c*. Each reservoir has its natural seasonal inflows. A water demand in downstream of these reservoirs is to be supplied. The main decision variables of this problem are capacities of the reservoirs.