Honey-bee mating optimization (HBMO) algorithm in deriving optimal operation rules for reservoirs

O. Bozorg Haddad, A. Afshar and M. A. Mariño

ABSTRACT

The honey-bee mating process is considered as a typical swarm-based approach to optimization, in which the search algorithm is inspired by the process of real honey-bee mating. In this paper, the honey-bee mating optimization (HBMO) algorithm is applied to extract the linear monthly operation rules of reservoirs for both irrigation and hydropower purposes. The release rules for each month are considered as a linear function of the reservoir past-month-end storage as well as current monthly inflow to the reservoir. In such a case, the decision variables are 36 for each problem and are set so that water supply deficits are minimized. In both irrigation and hydropower purposes, 60–480 months are considered and results are compared to those from the nonlinear programming solver of the LINGO 8.0 software. The approach and the rules tend to be very promising and denote the capability of the proposed HBMO algorithm in solving reservoir operation problems. Furthermore, the results indicated that, by using the near-optimal solution from the HBMO as a starting point for the NLP solver, the obtained objective function value was enhanced significantly and a better local optimum was found.

Key words | honey-bee mating optimization, hydropower, irrigation, operating rule, optimum reservoir operation

O. Bozorg Haddad (corresponding author)
Department of Irrigation and Reclamation,
Faculty of Soil and Water Engineering,
College of Agriculture and Natural Resources,
University of Tehran, Karaj, Tehran,
Iran
E-mail: *obhaddad@ut.ac.ir*

A. Afshar
Department of Civil Engineering and Center of Excellence for Fundamental Studies in Structural Mechanics,
Iran University of Science and Technology (IUST),
Tehran,
Iran

M. A. Mariño
Department of Civil and Environmental Engineering, and Department of Biological and Agricultural Engineering,
University of California,
139 Veihmeyer Hall (LAWR),
University of California,
Davis, CA 95616-8628
USA

INTRODUCTION

In reservoir operations for water supply, water can be either released for beneficial uses or retained in the reservoir for possible future use. This simple choice becomes extremely complex in the presence of uncertain future inflows and nonlinear economic benefits for released water (Shih & ReVelle 1994, 1995). The literature concerning development of operating rules for water resource systems is extensive, particularly for water supplies (Bower *et al.* 1962; Loucks & Sigvaldason 1982; Lund & Guzman 1996, 1999). In general, reservoir operating rules guide release decisions. Good reservoir management therefore requires creating "a set of operation procedures, rules, schedules, or plans that best meet a set of objectives" (USACE 1991). For water supply systems, the so-called standard operating policy (SOP) is perhaps the simplest reservoir operating rule. The SOP (Maass *et al.* 1962; Loucks *et al.* 1981) is specified as a function of the total value of currently available water (i.e. current storage, plus projected inflows, minus evaporation during the present period).

The coordinated operation of a reservoir system for efficient management of available water, to maximize the net benefit or minimize the total deficits of the system, is a complex decision-making process. The decision policies involve many variables, objectives, and considerable risk and uncertainty. They must satisfy various constraints on system operation while maximizing releases for various purposes such as irrigation, energy production, or minimizing spills and losses. Ideally, reservoirs in a system should be designed and operated together to maximize net social benefits. This aim can be reached using optimization approaches.

Over the last decade, evolutionary and meta-heuristic algorithms (EAs) have been extensively used as search and

doi: 10.2166/hydro.2008.018