

## Multiobjective water resources systems analysis using genetic algorithms – application to Chou-Shui River Basin, Taiwan

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**Abstract** Multipurpose operation is adopted by most reservoirs in Taiwan in order to maximize the benefits of power generation, water supply, irrigation and recreational purposes. A multiobjective approach can be used to obtain trade-off curves among these multipurpose targets. The weighting method, in which different weighting factors are used for different purposes, was used in this research work. In Taiwan, most major reservoirs are operated by rule curves. Genetic algorithms with characteristics of artificial intelligence were applied to obtain the optimal rule curves of the multireservoir system under multipurpose operation in Chou-Shui River Basin in central Taiwan. The model results reveal that different shapes of rule curves under different weighting factors on targets can be efficiently obtained by genetic algorithms. Pareto optimal solutions for a trade-off between water supply and hydropower were obtained and analyzed.

**Keywords** Chou-Shui River Basin; genetic algorithms; multiobjective programming; rule curves

### Introduction

The study of genetic algorithms (GAs) was originated by Holland (1975). GAs have been developed to become a powerful optimization approach. In the theory of GAs, Brindle (1981) improved the roulette wheel selection; Wright (1991) and Eshelman *et al.* (1992) developed real-value coding to solve related problems. GAs were applied to water resources systems by Goldberg and Kuo (1987) for pipeline optimization. Wang (1991) applied GAs to the calibration of a conceptual rainfall-runoff model. McKinney and Lin (1994), Ritzel *et al.* (1994), and Cieniawski *et al.* (1995) solved ground-water problems with GAs.

So far, there have been very few applications of GAs to reservoir systems optimization. East and Hall (1994) applied GAs to a four-reservoir problem; the objective was to maximize the benefits from power generation, irrigation and water supply. Fahmy *et al.* (1994) also applied GAs to a reservoir system, and compared the performance of the GAs with dynamic programming. Oliveira and Loucks (1997) used GAs to evaluate operating rules for a multi-reservoir system. Chang and Chen (1998) applied a GA to solve a flood control operation problem. Sharif and Wardlaw (2000) used GAs to solve a multi-reservoir system optimization problem in Brantas Basin located in Indonesia.

This research uses GAs for obtaining optimal rule curves in a reservoir system operation and finds the Pareto optimal solutions for water supply and hydropower generation in Chou-Shui River Basin in central Taiwan.

### Genetic algorithms

#### Characteristics of GAs

The need for solving optimization problems arises in almost every field. Genetic

# Multiobjective Analysis In Water Resources

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in consumer economics as considered by Edgeworth and Pareto. The critical question in an exchange economy concerns the equilibrium point at which each of  $N$  consumers has achieved the best possible deal for himself or herself. Ultimately this is a collective decision in which any further gain by one consumer can occur only at the expense of at least one other consumer. Such an equilibrium concept was first introduced by Edgeworth in 1881 in his book on mathematical psychics. Today such an optimum is variously called Pareto optimum after the Italian French welfare economist who continued and expanded

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## **Table of Contents Multiobjective Analysis In Water Resources**

1. Understanding the eBook Multiobjective Analysis In Water Resources
  - The Rise of Digital Reading Multiobjective Analysis In Water Resources
  - Advantages of eBooks Over Traditional Books
2. Identifying Multiobjective Analysis In Water Resources
  - Exploring Different Genres
  - Considering Fiction vs. Non-Fiction
  - Determining Your Reading Goals
3. Choosing the Right eBook Platform
  - Popular eBook Platforms
  - Features to Look for in an Multiobjective Analysis In Water Resources
  - User-Friendly Interface
4. Exploring eBook Recommendations from Multiobjective Analysis In Water Resources
  - Personalized Recommendations
  - Multiobjective Analysis In Water Resources User Reviews and Ratings

- Multiobjective Analysis In Water Resources and Bestseller Lists
- 5. Accessing Multiobjective Analysis In Water Resources Free and Paid eBooks
  - Multiobjective Analysis In Water Resources Public Domain eBooks
  - Multiobjective Analysis In Water Resources eBook Subscription Services
  - Multiobjective Analysis In Water Resources Budget-Friendly Options
- 6. Navigating Multiobjective Analysis In Water Resources eBook Formats
  - ePUB, PDF, MOBI, and More
  - Multiobjective Analysis In Water Resources Compatibility with Devices
  - Multiobjective Analysis In Water Resources Enhanced eBook Features
- 7. Enhancing Your Reading Experience
  - Adjustable Fonts and Text Sizes of Multiobjective Analysis In Water Resources
  - Highlighting and Note-Taking Multiobjective Analysis In Water Resources
  - Interactive Elements Multiobjective Analysis In Water Resources
- 8. Staying Engaged with Multiobjective Analysis In Water Resources
  - Joining Online Reading Communities
  - Participating in Virtual Book Clubs
  - Following Authors and Publishers Multiobjective Analysis In Water Resources
- 9. Balancing eBooks and Physical Books Multiobjective Analysis In Water Resources
  - Benefits of a Digital Library
  - Creating a Diverse Reading Collection Multiobjective Analysis In Water Resources
- 10. Overcoming Reading Challenges
  - Dealing with Digital Eye Strain
  - Minimizing Distractions
  - Managing Screen Time
- 11. Cultivating a Reading Routine Multiobjective Analysis In Water Resources
  - Setting Reading Goals Multiobjective Analysis In Water Resources
  - Carving Out Dedicated Reading Time
- 12. Sourcing Reliable Information of Multiobjective Analysis In Water Resources
  - Fact-Checking eBook Content of Multiobjective Analysis In Water Resources
  - Distinguishing Credible Sources

13. Promoting Lifelong Learning
  - Utilizing eBooks for Skill Development
  - Exploring Educational eBooks
14. Embracing eBook Trends
  - Integration of Multimedia Elements
  - Interactive and Gamified eBooks

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