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Team Control Number
59468

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2017
MCM/ICM
Summary Sheet

With the rapid aging of the Kariba Dam, which impounds the world's largest man-made lake and reservoir by volume, the optional solution for the maintenance of the dam has become a universal concern.

As for the first requirement, we analyze the options for repairing or rebuilding the dam. Then, we generally assess the details of their potential costs and benefits. Finally, we carefully examine the potential costs and benefits of the three different options, and therefore obtain the advantages and disadvantages of each option. Considering comprehensive information we analyzed, option3 seems to be a good choice.

For the second requirement, we successfully present a detailed analysis for the third option in a technical way. A general **site selection model** applying modified risk score method we proposed is established to confirm the optimum number of dams and their locations on the river, which are achieved by first determining the available dam sites and then choosing some for construction of dams. As for the former, we use the data acquired from Geographic Information System (GIS) to obtain the changes in elevation and width of the whole river, and successfully select 30 feasible dam-building addresses. Then, a **bi-objective optimization model** minimizing the cost and risk is presented for confirmation of locations and scales of dams to be constructed. Subject to the upper bound of dam height, we solve it by a hybrid particle swarm optimization (HPSO) algorithm, convergence of which is accelerated by discretizing the feasible height intervals of dams. Finally, we acquire a local optimal solution that the number of the selected dams is 16 and the other information about the selected dams are shown in the Appendix.2.

In order to provide guidance for water resources scheduling in cascade dam systems, we establish a **discrete dynamic regulation model.** Introducing two kinds of safety grade judgment basis, we establish a bi-objective optimization model. Then we consider three different cases: flooding or prolonged low water condition, the water flows ranging from maximum expected discharges to minimum expected discharges condition and partial area of the system being exposed to the most detrimental effects of the extreme conditions.

For model validations, we use the appropriate data transformation to determine the initial value of the model, and solve it under three possible conditions utilizing the **progressive optimality algorithm (POA)**. Finally, we provide the **dynamic regulation strategy** for each condition.

We simulate the whole calculation procedure via computer. The cascade dam systems selected by our site selection model has a high average safety level and competitive total construction costs.

Also, we choose the discrete height interval of the dam for sensitivity analysis. And the results indicate that our model is very robust. Also, in the sensitivity analysis of the risk assessment method, we find the possible problems and point out the corresponding solutions.