Technical report

Comparison of Meta-heuristic Algorithms Optimization of Discharge and Suspended Sediment Discharge Relation in Sistan River

Mohammadrezapour, O and Zeynali, M.J.
Faculty of Soil and Water, University of Zabol, 98615, Zabol, Iran

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Introduction

Proper estimation of sediment concentration in rivers is a key factor for implementing water resource projects planning and managements. To date, various models have been developed to identify the relationship between discharge and sediment load. One of the most common methods for estimating sediment of rivers is sediment rating curve. For better estimation of the amount of suspending sediment based on the sediment curve rating equation, it is possible to optimize the coefficients of this equation. One of the methods used for optimizing the coefficients of the sediment curve rating equation is taking advantage of meta-heuristic algorithms. The main objective of this research is using Genetic, particle swarm, ant colony, the elite ant and maximum - minimum ant algorithms to optimize the relationship between discharge and sediment discharge in Kohak station on the Sistan River as well as comparing the results of these models with sediment rating curve.

Methods

Sistan Plain is located in the estern border of Iran, 10° 60' to 50 ° 61 ' NE and 30° 18’ to 20° 31' LN. This plain with an area of 250 ha, is a part of the areas of Zabol City located at the northern end of Sistan and Baluchestan province. Sistan river which is located in the geographic area of 30° 40' to 55 ° 30' north latitude and 61° 25' to 30° 45' east longitude runs from the upper area to the mouth and follows the pattern of the regular meander ricers. The main objective of this research is using the meta-heuristic algorithms to optimize the coefficients of the sediment rating curve on the Sistan River located in the Kohak station and to compare the results of these models with the sediment rating curve. For calculating the flow rate of the sediment, first, the required data including water discharge and sediment concentration measurements was collected at the station from 1980 until 2012. In spite of very different methods for developing the rating curves, the most common method is the power function of the form $Y = aX^b$ which relates the suspended sediments concentrations to water discharge. Sediment rating curve expresses the sediment load, Q_s, at a cross-section from the river through its discharge, Q_w, as follow: $Q_s = aQ_w^b$.

Genetic, particle swarm, ant colony, the elite ant and maximum - minimum ant algorithm models were coded in MATLAB. After the models were trained with 70% of the data, 30% of it was tested at station. Evaluation parameters efficiency such as coefficient of determination (R^2), root

mean square error (RMSE) and Nash-Sutcliffe coefficients (CE) were used for evaluating the models.

Results

All the models and sediment rating curves were run in the Kohak station. The results of the models, minimizing the error rate of the calculated data and the actual rates, indicate the fact that elite ants' algorithm with a root mean square error rate of 32728.54 has the minimum rate of the objective function compared to those of the algorithm of Genetic Algorithm , 33484.47. It has been able to minimize the rate of the objective function in the best possible way. Moreover, other evaluation parameters such as efficiency and Nash-Sutcliffe coefficients were used in evaluating the models. The results of this evaluation also indicated that in comparison with the two other models, the elite ant algorithm has higher efficiency and Nash-Sutcliffe coefficients. In general, it can be concluded that all algorithms used in this study are able to optimize the coefficients of the sediment rating curve model; however, the elite ants' algorithm possesses a higher accuracy than other algorithms