Research Paper

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Evaluating the Efficiency of New Hybrid Artificial Intelligence Models to Estimate Flood Discharge Kashkan Basin

Saeed Rostami [1], Babak Shahi Nejad [*2], Hojjatollah Younesi [3], Hassan Torabipoudeh [4] Reza Dehghani [5]

1-Ph.D. Student in Hydraulic Structures, Faculty of Agriculture, Lorestan University
2-Assistant Professor, Department of Water Engineering, Faculty of Agriculture, Lorestan University
3-Assistant Professor, Department of Water Engineering, Faculty of Agriculture, Lorestan University
4-Associate Professor of Water Engineering, University of Lorestan
5-Ph.D. Student in Hydraulic Structures, Faculty of Agriculture, Lorestan University

1-Introduction

Human beings have long grappled with the problem of the flood as one of the natural phenomena. Iran is not the exception to the rule. Every year the country strikes by devastating floods that often cause heavy casualties due to its vast area, spatial and temporal changes in the rainfall pattern in most basins, and having different climates. Today, artificial intelligence systems, including artificial neural networks, are widely used as an effective way to simulate hydrological processes. They have some errors in the estimation of networks parameters (weights and biases) due to their trial-error nature. As a result, researchers have combined artificial intelligence systems with an optimization algorithm to moderate errors and improve their function.

In the present research, modern artificial intelligence models, including an innovative gunner, black widow spider, and hen swarm, were used to estimate flood discharge of the Kashkan catchment basin in Lorestan from 2011 to 2021.

2-Method

The Kashan catchment basin with an area of 66.97 square kilometers is in the southwest of Iran. It is the most flood-stricken river in Lorestan. It is a major tributary of the Karkhe River, covering almost one-third of this region. It is considered a part of the Persian Gulf catchment according to the Iranian hydrological division.

In recent years, artificial neural networks have been widely used in hydrological studies and water resources management. An artificial neural network normally consists of three layers including input, middle, and output. The input layer serves as a transmitter layer and provides data. The output layer includes the values predicted by the network. And the middle or hidden layer is composed of processor nodes in which data are processed.

*Corresponding author; **E-mail:**shahinejad.b@lu.ac.ir

Artificial neural network

Today, artificial neural networks are widely used in hydrological studies and water resources management. The structure of the neural network usually consists of the input layer, the middle layer and the output layer. Input layer A transmitter layer and a means of providing data. The output layer contains the values predicted by the network and the middle or hidden layer, which consists of processor nodes, is the data processing site.

Innovative Gunner algorithm

The algorithm of the innovative gunner (AIG) is one of the state-of-the-art Meta-heuristic optimization algorithms proposed by Pijarski and Kasjko (2019). Having a powerful structure, the algorithm is expected to be widely used in various scientific and technological fields in the future. It is able to solve various optimization tasks in different fields such as mechanics and benchmark mathematical operations efficiently and fast. One of the many advantages of this algorithm is that it can find the most accurate solution in a short time and at the lowest cost due to it great convergence speed.

Black Widow Spider Algorithm

This algorithm was first proposed by Sebastian and Peter (2009). It is based on the survival of the superior or natural selection, so that the early spiders, in pairs, tried to reproduce the new generation, and the black widow ate the male during or after mating, then she carried his sperm stored in sperm cavities and finally released them into the egg sacs.

Chicken swarming algorithm

Chicken swarm optimization is a bio-inspired algorithm used for single-objective optimization. It was first proposed by Meng et al. It simulates the hierarchical order and behavior of a flock of hens when searching for food, so each hen represents a potential solution to an optimization problem.

Grasshopper Optimisation Algorithm

It was proposed by Saremi et al. (2017). Like other optimization algorithms, it tries to find the optimal solution among several ones. The proposed algorithm simulates the behavior presented in swarms of locusts for food search.

It is one of the latest meta-heuristic algorithms. It is categorized as a collective intelligence algorithm and emulates the social behavior of locusts as well as how each locust is affected by its surrounding environment. In this study, such statistical indices as the coefficient of determination (R2), mean absolute error (MAE), Nash-Sutcliffe

efficiency coefficient (NSE), and percentage of Bias were used to evaluate the simulation performance.

3-Results and discussion

The results showed that hybrid artificial intelligence models could improve the performance of the single model. Moreover, the combined artificial neural network-innovative gunner model illustrated more accuracy and less error than the artificial neural network-black widow spider, artificial neural network--chicken swarm, artificial neural network- Grasshopper Optimisation Algorithm, and single artificial neural network. The results also showed that the four models could estimate the flood discharge rate accurately.

4-Conclusion

This study supported the efficiency of the artificial neural network-innovative gunner model to estimate flood discharge. In addition, the results showed that this model works best to increase the development and implementation of strategies for surface water resources management. Therefore, it can be considered as an important step toward making decisions to improve the number of surface water resources.

Keywords: Innovative Gunner, Simulation, Artificial Intelligence, Southwest, Kashkan Basin.