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Simulating Groundwater Level of Selseleh Plain in Lorestan Province Using Modern Metaheuristic Algorithms

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1-Introduction

Rising population and the need to optimally use water resources require providing the highest amount of groundwater to meet human needs. Improper utilization of groundwater resources in recent years has disrupted its natural balance as groundwater levels in aquifers have turned negative in many areas of the world and Iran. Thus, it is critical to accurately predict fluctuating groundwater levels to understand the status of these resources and to optimally manage them. To simulate the groundwater level of the Selseleh plain southwest of the country via a monthly-basis scale from 2010 to 2020, this study used the hybrid wavelet transform (WT)-support vector regression (SVR) as well as meta-heuristic Gray Wolf Optimizer (GWO) and Bat Algorithm (BA) algorithms to optimize the adjustment parameters.

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2-Methodology

Lorestan province in Iran is one of the mountainous provinces west of the country whose most areas are covered by the Zagros Mountains. Its basin is a sub-basin of the Kashkan River, which part of the Karkheh basin is considered to be one of the main Iranian basins. This plain is the most important source of agricultural products which require groundwater for growth. Thus, it is necessary to change the water level to predict and manage water improvement measures. The Selseleh plain is irrigated based on rainfall parameters, temperature, and groundwater level using a hybrid model of support vector regression and optimization algorithms such as Gray Wolf, Bat Algorithm, and wavelet transform.

The support vector machine is a constrained optimization theory-based effective learning system that makes use of the inductive principle to minimize structural errors and to arrive at a general optimal solution. The wavelet transform has been suggested to replace the short-term Fourier transform, aiming to remove problems from frequency resolution power in the short-term Fourier transform. In wavelet transform, as in the short-term Fourier transform, the signal is divided into windows with the wavelet transforming on each of these windows individually (Vapnik, 1998). A wavelet is a small wave, component, or window of the main signal concentrating its energy in time. Using wavelet transform analysis, the mother signal or time series can be divided into wavelets of various levels and scales.

The GWO algorithm is a meta-heuristic algorithm inspired by the hierarchical structure and social behavior of hunting gray wolves. This is a population-based algorithm with a simple process that can be easily generalized to bigger problems. Gray wolves are considered the best hunters on the top of the food chain pyramid. Gray wolves prefer to live in a group, with each group having an average of 5 to 12 members. All members of this group are socially dominant and have certain tasks.

Collective intelligence is one of the strongest optimization techniques that use group behaviors (Amuda et al., 2013). Proposed by Young in 2010, the Bat Algorithm is a metacognitive algorithm that uses the collective behavior of bats in the natural environment. This algorithm considers bats' sound echo as its basis. Bats find their path and the exact location of their prey by transmitting sound waves and receiving their echoes. When the sound waves return to the wave transmitter (bat), it can create a sound image of the obstacles in its surroundings and see the environment well

even in complete darkness. Using this system, bats can detect moving objects such as insects and fixed objects such as trees.

3- Results and Discussion

Results and Discussion, , Results and Discussion, Results and Discussion, The findings indicated that all three models of structures 1 to 4 times a day yielded better results than other specified structures. Moreover, considering the comparison criteria of models, it was found that the hybrid wavelet-support vector regression model well simulated the groundwater level. The results showed that the hybrid support vector model could be used to simulate the groundwater level.

4- Conclusions

The results suggested that increasing the number of effective simulation parameters in different models could have better efficiency of groundwater level simulation. Moreover, the hybrid wavelet-support vector machine model was found to have better performance.

Keywords: Water level drop, Support vector regression, Selseleh plain