Chapter 52
Dead Sea Water Levels Analysis Using Artificial Neural Networks and Firefly Algorithm

Nawaf N. Hamadneh
https://orcid.org/0000-0002-2170-2074
Saudi Electronic University, Saudi Arabia

ABSTRACT

In this study, the performance of adaptive multilayer perceptron neural network (MLPNN) for predicting the Dead Sea water level is discussed. Firefly Algorithm (FFA), as an optimization algorithm is used for training the neural networks. To propose the MLPNN-FFA model, Dead Sea water levels over the period 1810–2005 are applied to train MLPNN. Statistical tests evaluate the accuracy of the hybrid MLPNN-FFA model. The predicted values of the proposed model were compared with the results obtained by another method. The results reveal that the artificial neural network (ANN) models exhibit high accuracy and reliability for the prediction of the Dead Sea water levels. The results also reveal that the Dead Sea water level would be around -450 until 2050.

1. INTRODUCTION

A key aspect of water resources management activities is to predict the level of water bodies such as seas, rivers, and lakes (Ghorbani, Deo, Karimi, Yaseen, & Terzi, 2018; Yaseen et al., 2018). Artificial neural networks (ANNs) models were used successfully to model the lakes and the river systems without using experimental apparatuses(Buyukyildiz, Tezel, & Yilmaz, 2014; Esbati, Khanesar, & Shahzadi, 2017; Kakahaji, Banadaki, Kakahaji, & Kakahaji, 2013; Yaseen et al., 2018). Also, using an optimization scheme in a predictive model can thus improve the performance of the NN models(Asteris & Nikoo, 2019; Ghorbani et al., 2018; Walczak, 2019).

The Dead Sea consists of the world's biggest lakes and the water lakes threatened by drought due to several factors such as lack of rain and exploitation of sea water (Al Rawashdeh, Ruzouq, Pradhan, Ziad, & Ghayda, 2013; Dente, Lensky, Morin, Dunne, & Enzel, 2018). The Dead Sea is a unique and

DOI: 10.4018/978-1-6684-2408-7.ch052

essential environment from an economic, environmental and tourist point of view (Kiro et al., 2017). Numerous scientific studies have been published on the degradation of the Dead Sea water level using radar interference (Al-Hanbali, Al-Bilbisi, & Kondoh, 2005; Closson et al., 2003). After that, Landsat images for the period 1810–2005 was used to study the fluctuation level of the Dead Sea surface area (Al Rawashdeh et al., 2013). In their study, the geographic information system (GIS) and Global Positioning System were used to predict of Dead Sea water level. In recent years, the intelligent methods have been largely used in prediction of water level fluctuations in lakes (Esbati et al., 2017; Ghorbani et al., 2018; Kakahaji et al., 2013). They have used hybrid artificial intelligence approaches and statistical analysis or water level prediction. Moreover, no one used artificial intelligence models to estimate the Dead Sea water levels.

In this study, the prediction of the future water level of the Dead Sea is investigated using multilayer perceptron neural network (MLPNN) which is trained using the firefly algorithm (FFA). One of the main advantages of MLPNN-FFA method is that FFA can easily optimally estimate the parameters of MLPNN. Furthermore, the accuracy of the used methods is evaluated using various statistical parameters. Using an optimization scheme in a predictive model can thus utilize the best NN parameters.

This paper is organized as follows. In Section 2, different methods including MLPNN and FFA are described. In Section 3, the experimental results are discussed. Finally, Section 4 concludes this study.

2. METHODS

2.1. Multilayer Perceptron Neural Network

ANNs are mathematical models which are *inspired* by the way the *biological* nervous systems (Ghorbani et al., 2018; N. Hamadneh, Khan, & Tilahun, 2018; N. N. Hamadneh, Khan, & Khan, 2018; Heidari, Faris, Aljarah, & Mirjalili, 2018; Pham, Bui, Prakash, & Dholakia, 2017). MLPNN is one of the widely known of feedforward artificial neural networks(Ghiasi, Irani Jam, Teimourian, Zarrabi, & Yousefi, 2019). In this study, MLPNN has used for prediction the water level of the Dead Sea, where Figure 1 shows the location of the Dead Sea (https://www.nationsonline.org/oneworld/map/jordan_map.htm, 2018).

MLPNNs have three types of layers, which include the input layers, hidden layers, and the output layer. Figure 2 shows a structure of MLPNN (Jadidi, Menezes, de Souza, & de Castro Lima, 2018; Mefoued, 2013; Yeung, Li, Ng, & Chan, 2016).

The activation function (sigmoid function) in the hidden layer can be written as:

$$y = tanhx = \frac{1 - e^{-2x}}{1 + e^{-2x}} \tag{1}$$