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Research Paper

Hydrological Drought Forecasting, using Artificial Neural Network (ANN) and Predict Values of Hydrological Drought Condition Derived using River Water Level Data

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Abstract: This paper focuses on hydrological drought forecasting, using Artificial Neural Network (ANN) and predicts the values of hydrological drought condition derived using Narmada River Water level data of Hoshangabad (M.P). We have used the water level data as input data of ANN model for hydrological drought forecasting, and determine Standardized Water Level Index (SWLI). Artificial Neural networks operate on the principle of learning from a training set. There is a large variety of neural network models and learning procedures. Two classes of neural networks that are usually used for prediction applications are feed-forward networks and recurrent networks. They often train both of these networks using back-propagation algorithm.

Keywords: Artificial Neural Network, Hydrological Drought, RWL.

1. Introduction

Artificial intelligence (AI) is a growing trend in computer automation systems. Several types of artificial intelligence technology are available. These include robotics, voice-recognition systems, and many smart computer systems. Artificial intelligence refers to any computer system that uses a logical process to learn and improve, based on the surrounding environment and prior mistakes. This technology is undergoing a great evolution, but is still far short of the capacity of the human brain. It may take several decades before computers will can actually use logic to determine the best approach for problem solving. The current AI systems can learn, but in a limited spectrum. This is because the human brain processes thousands of variables to solve a specific problem.

2. Artificial Neural Network

Neural networks provide a method for extracting patterns from noisy data. We have applied them to a wide variety of problems, including cloud classification (Bankert,[2], 1994) and tornado warnings (Marzban and Stumpf,[3], 1996) in a meteorological context. We discuss the advantages and disadvantages of neural networks in comparison to other statistical techniques for pattern extraction in (Marzban and Stumpf,[3] (1996)). We can find more detail about the construction of neural networks in (Marzban and Stumpf,[3] (1996)) and (Mu̓ller and Reinhardt,[4] (1991)) and references therein. The standard procedure for use of a neural network involves ‘‘training’’ the network with a large sample of representative data. The network has some number of input and output ‘‘nodes’’ representing the predictor and predict and variables, respectively. In between, there are a number of hidden nodes arranged in layers. The number of hidden nodes and layers is usually determined empirically to optimize performance for the particular situation. Each connection between nodes on a particular layer and the layer above it can be represented by a weight, viz. that indicates the importance of that connection between the i^{th} and j^{th} nodes. The training phase of the neural network is designed to optimize the weights so that the mean-squared error of the output is minimized. For each node at a particular layer, the input node values from the previous layer are multiplied by the weight of the connections between the nodes and then all of the different connections are summed to produce the value at that node. This process is repeated for all nodes and then for each layer. The network then can be used to make predictions based on new input values.

3. Use of Artificial Neural Networks (ANNs) for Forecasting Hydrological Drought Condition.

In recent decades artificial neural networks (ANNs) have shown exceptional ability in modelling and forecasting non-linear and non-stationary time series and in most of the cases especially in prediction of phenomena have showed excellent performance.

This discussion presents the application of artificial neural networks to predict hydrological drought in Hoshangabad (M.P). In this paper, different architectures of artificial neural networks in water level data have been used as inputs of the models. According to the results taken from this research, dynamic structures of artificial neural networks, including Recurrent Network (RN) and Time Lag Recurrent Network (TLRN) showed better performance for this application (because of higher accuracy of its outputs). Finally, TLRN network with only one hidden layer and hyperbolic tangent transfer function was the most appropriate model structure to predict hydrological drought for the next year. In fact, by a prediction of the hydrological drought before its occurrence, it is possible to evaluate hydrological drought characteristics in advance. It was found that ANN is an efficient tool to model and predict hydrological drought events.

Artificial Neural networks operate on the principle of learning from a training set. Two classes of neural networks that are usually used for prediction applications are feed-forward networks and recurrent networks. We often train both of these networks using the backpropagation algorithm. An advantage of backpropagation is that it is simple. Prediction networks usually take the historical measured data, and after some processing stages, future condition is simulated. In this research, after evaluation and testing of different ANN Structures, TLRN and RN we selected networks because of their higher performance, and then between these two, TLRN network showed slightly higher abilities. Therefore, TLRN was the final selected ANN type for hydrological drought prediction in this study.

4. Hydrological Drought

A hydrological drought occurs when precipitation has been reduced for an extended period of time, and water supplies found in streams, lakes, rivers, and reservoirs are deficient with demand exceeding supply.

It is associated with the effects of periods of precipitation shortfalls on surface or ground water supply. Hydrological droughts usually lag the occurrence of meteorological and agricultural droughts as it takes longer time to occur. As an example, a precipitation deficiency may result in a rapid depletion of soil moisture that can easily affects crop production, but the impact of this deficiency on reservoir levels may affect hydroelectric power production only if the precipitation deficiency persist for a longer period.

Meteorological drought often leads to reduction of natural stream flows or groundwater levels, plus stored water supplies. Main impact is on water resource systems.

To assess hydrological drought are surface-water area and volume, surface runoff, stream flow measurements, infiltration, water-table fluctuations, and aquifer parameters.

5. Study Area and Data Source

Hoshangabad:

Hoshangabad is located at 22.75°N 77.72°E.[1] It has an average elevation of 278 metres (912 feet).Northern boundary of the district is river Narmada. Across this the district of Raisen and Sehore lies. The district of Betul lies in the south, where as the Harda district faces with the western and south-western boundaries and Narsingpur and Chhindwara districts, close to the north-eastern and south-eastern sides of the district respectively. The climate of Hoshangabad district is normal. All the seasons come in the district. An average height from the sea level is 331 mts.and average rain fall is 134 cms. The average maximum and minimum temperatures are 32 deg.C and 19 deg.C respectively. Overall, the climate of the district is neither more hot nor more cool except the winter season of the Pachmarhi.

Narmada River:

The Narmada river is the longest river in Madhya Pradesh. It flows westward through a rift valley, with the Vindhya ranges sprawling along its northern bank and the Satpura range of mountains along the southern.

Its tributaries include the Banjar, the Tawa, the Machna, the Denwa and the Sonbhardra rivers. The Tapti River runs parallel to Narmada, and also flows through a rift valley. The Narmada–Tapti systems carry and enormous volume of water and provide drainage for almost a quarter of the land area of Madhya Pradesh.

The Vindhyas form the southern boundary of the Ganges basin, with the western part of the Ganges basin draining into the Yamuna and the eastern part directly into the Ganges itself. All the rivers, which drain into the Ganges, flow from south to north, with the Chambal, Shipra, Kali Sindh, Parbati, Kuno, Sind, Betwa, Dhasan and Ken rivers being the main tributaries of the Yamuna.

6. Standardized Water Level Index (SWI/SWLI)

In order to monitor hydrological drought in the Madhya Pradesh, the pre monsoon and post-monsoon water levels of River Narmada of the study region have been analyzed. SWLI has been developed to scale the river water level. The SWI expression stands as

$$\textbf{SWLI} = \frac{Wij - Wim}{\sigma}$$

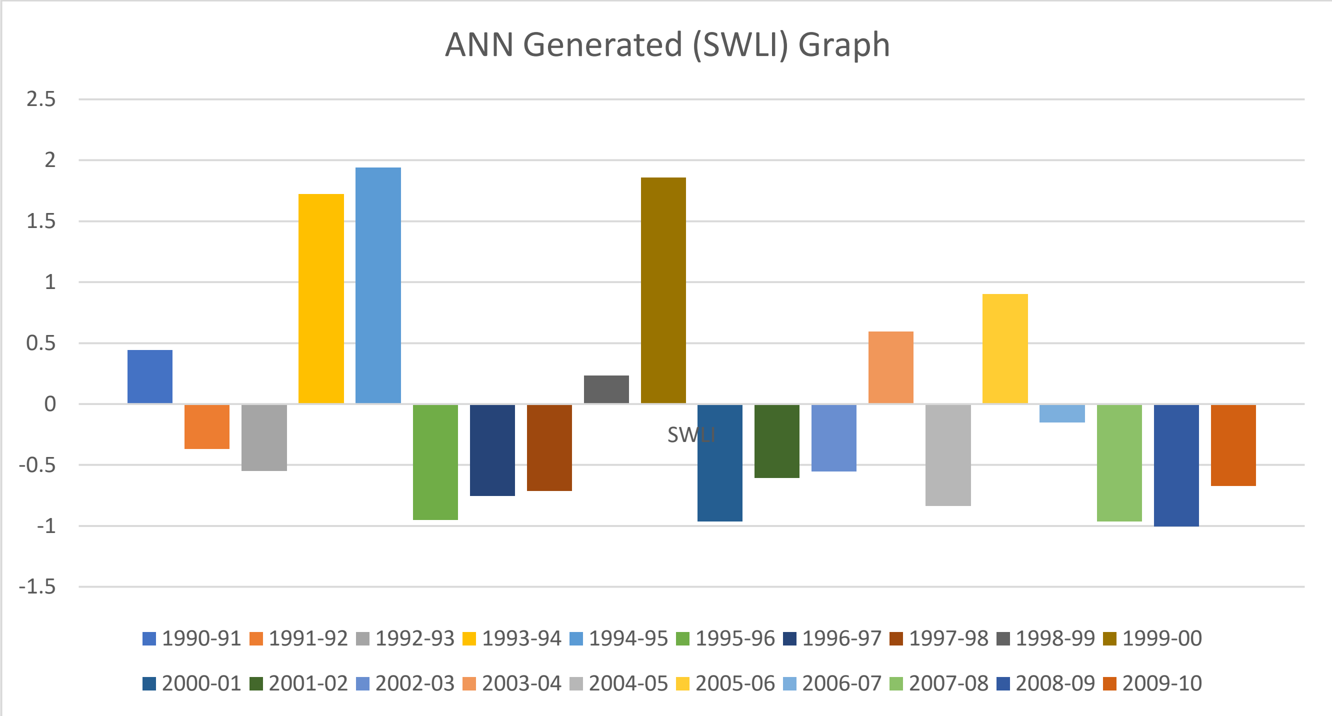
Where, *Xij* is the seasonal water level at the ith gauge station and jth observation, *Xim* is its long-term seasonal mean water level and σ is its standard deviation.

The classification of the (Hydrological Drought) intensities based on the SWLI value is as follows;

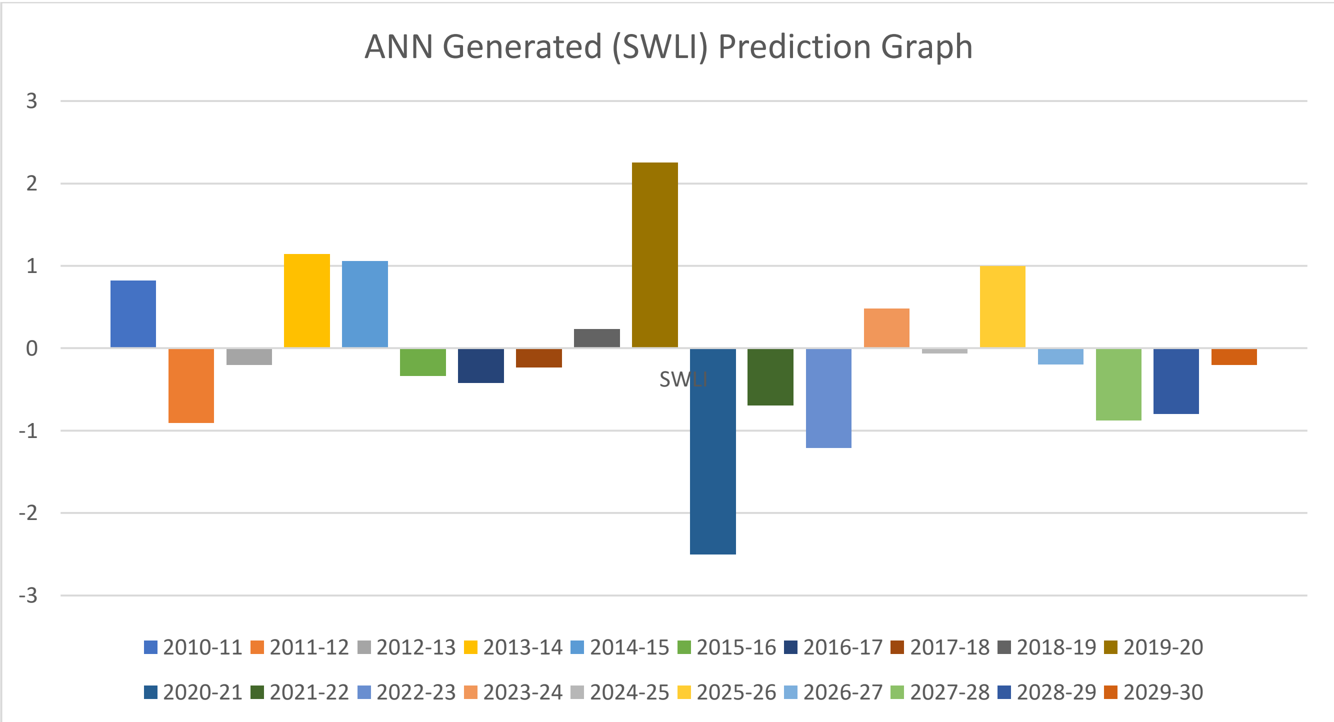
Table.1. SWLI

2.0 +	Extremely Wet
1.5 to 1.99	Very Wet
1.0 to 1.49	Moderately Wet
-.99 to .99	Near Normal
-1.0 to -1.49	Moderately Dry
-1.5 to -1.99	Severely Dry
-2 and less	Extremely Dry

7. ANN Generated (SPI) Graph



Graph-1 ANN Generated Actual (SWLI) Graph



Graph-2 ANN Generated Prediction (SWLI) Graph

8. Conclusion

Initially, the ANN model has been conducted on the whole dataset. We have performed graphical visualization in order to make it easier to understand the data itself graph 1and 2 shows it.

The SWLI graph generates by ANN model indicate that hydrological drought appears in the Hoshangabad region in a random fashion. From graph 1 the negative bars in years 2008-09, show over all moderate dry condition in these years and remaining years show mild dry occurrence. The positive bars in years 1990-91, 1998-99, 2003-04, 2005-06, show that good rainfall condition while in years 1993-94, 1994-95, 1999-00, show Severely Wet Condition.

Similarly, from prediction graph 2 the negative bars in years 2020-21 show extremely hydrological drought condition, while 2022-23 show moderately hydrological drought condition occurrence in these years. The positive bars in years 2010-11, 2025-26 show that good rainfall condition while in year 2019-20, shows extremely Wet condition. It is observed that the actual result is very close to the predicted result in concerned area.

References

[1] Agnew, C. T.: Using the SPI to identify drought. Drought Network News, Vol.**12**, Issue.**1**, pp.**6–11, 1999.**

[2] Bankert, R. L.: Cloud classification of AVHRR Imagery in maritime regions using a probabilistic neural network, J. Appl. Meteorol., Vol.**33**, pp.**909–918, 1994.**

[3] Marzban, C. and Stumpf, G. J.: A neural network for tornado prediction based on Doppler radar-derived attributes. J. Appl. Meteor., Vol.35, pp.**617–626, 1996.**

[4] Mu¨ller, B., and Reinhardt, J.: Neural Networks: An Introduction, the Physics of Neural Networks Series, Springer-Verlag, Vol.**2**, pp **266, 1991.**

