# Drought forecasting, using Artificial Neural Network (ANN) and predictvalues of drought condition derived using Remote Sensing data

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## Abstract:

This paper focuses on drought forecasting, using Artificial Neural Network (ANN) and predicts the values of drought condition derived using Remote Sensing data of Bhopal (M.P). We haveused the NDVI data as input data of ANN model for drought forecasting, and determine Standard Vegetation Index (SNDVI).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.

# **1.1 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.

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The 6 major areas of Artificial Intelligence comprise:

1. Intelligent Systems 2. Knowledge **3.Demons 4.Expert Systems** 5.Agents 6. Neural Networks

# **1.2 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,[1], 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 (Mu <sup>6</sup>ller 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<sup>th</sup> and j<sup>th</sup> 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.

#### 1.3 Use of Artificial Neural Networks (ANNs) for forecasting 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 drought in meteorological station Bhopal (M.P). In this paper, different architectures of artificial neural networks in Remote Sensing (NDVI) 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 drought for the next year. In fact, by a prediction of the Drought before its occurrence, it is possible to evaluate drought characteristics in advance. It was found that ANN is an efficient tool to model and predict 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 networksbecause of their higher performance, and then between these two, TLRN network showed slightly higher abilities. Therefore, TLRN was the final selected ANN type for drought prediction in this study.

# 1.4 STUDY AREA AND DATA SOURCE

#### **Bhopal:**

The geographical location of the city of Bhopal lies within North Latitude 23°16' and East Longitude 77°36'. The location of Bhopal falls in the north-western portion of Madhya Pradesh. If seen in the Map of India, Bhopal occupies the central- most region of the country. The city of Bhopal shares its border with two large and picturesque lakes. Like few other big

cities of the country. We refer the two lakes of Bhopal City to as the Upper and the Lower Lake.

Bhopal has a humid subtropical climate, with mild, dry winters, a hot summer and a humid monsoon season. Summers start in late March and continue till mid-June, the average temperature being around 30 °C (86 °F), with the peak of summer in May, when the highs regularly exceed 40 °C (104 °F). The monsoon starts in late June and ends in late September. These months see about 40 inches (1020 mm) of precipitation, frequent thunderstorms and flooding. The average temperature is around 25 °C (77 °F) and the humidity is quite high. Temperatures rise again up to late October when winter sets in, which lasts up to early March. Winters in Bhopal are mild and dry, with average temperatures around 18 °C (64 °F) and little or no rain. Total annual rainfall is about 1146 mm (46 inches).

#### **1.5 Normalized Difference Vegetation Index (NDVI):**

The Normalized Difference Vegetation Index (NDVI) is a graphical indicator derived from the remote sensing data and is used to carry out the vegetation index. Normalized Difference Vegetation Index (NDVI) uses Band 1 (red), Band 2 (near infrared) and cloud data when available (NDVI, 2013). We base the composite values on data quality and the maximum NDVI for the compositing period. The NDVI is a ratio of the red and near infrared reflectance. It is useful for assessing the health and density of vegetation. NDVI values near 0 such as -0.1 to 0.1 show barren areas of rock, sand or snow. Higher values of 0.1 to 0.4 show sparse vegetation of grassland and shrubs. NDVI values approaching values of 1 indicated dense vegetation like tropical rainforests orit directly related NDVI to the photosynthetic capacity and energy absorption of plant canopies (Sellers,[5], 1985). To calculate the vegetation, cover the differences in reflectance has to be looked up on (Crippen,[2], 1990).

I stated the formula to detect the NDVI:

$$NDVI = \frac{NIR - VIS}{NIR + VIS}$$

Where NIR is near-infrared and VIS is visible-infrared.

In this study first calculate SNDVI by this given formula:

$$SNDVI = \frac{NDVIi - NDVIm}{\sigma}$$

And calculate the drought category result from the SNDVI value using ANN model

And also according to the previous year predict drought year using the Artificial Intelligence algorithm and generate the SNDVI data value

YEAR	SNDVI	RESU	JLT YEAR	SNDVI	PREDICTION RESULT
2002-3	-2.018209311	Extremely Dry	2012-2013	-0.3975624	Near Normal
2003-4	-0.133793521	Near Normal	2013-2014	-0.0182476	Near Normal
2004-5	0.205401321	Near Normal	2014-2015	0.16968617	Near Normal
2005-6	-0.962936469	Near Normal	2015-2016	-0.3975624	Near Normal
2006-7	0.016959742	Near Normal	2016-2017	0.01223561	Near Normal
2007-8	0.299622110	Near Normal	2017-2018	0.03860502	Near Normal
2008-9	-0.812183205	Near Normal	2018-2019	-0.6243089	Near Normal
2009-10	0.921479321	Near Normal	2019-2020	0.89127948	Near Normal
2010-11	1.599869006	Very Wet	2020-2021	1.15668248	Moderately Wet
2011-12	0.883791005	Near Normal	2021-2022	0.26764137	Near Normal
2012-13	0.0	NULL	2022-2023	0.0	NULL
2013-14	0.0	NULL	2023-2024	0.0	NULL
2014-15	0.0	NULL	2024-2025	0.0	NULL
2015-16	0.0	NULL	2025-2026	0.0	NULL
2016-17	0.0	NULL	2026-2027	0.0	NULL
2017-18	0.0	NULL	2027-2028	0.0	NULL
2018-19	0.0	NULL	2028-2029	0.0	NULL
2019-20	0.0	NULL	2029-2030	0.0	NULL
2020-21	0.0	NULL	2030-2031	0.0	NULL

# **1.6 ANN OUTPUT TABLE**

## **1.7 ANN GENERATED GRAPH**

## **GRAPH-1**



# 1.8 GRAPH-2

#### ANN GENERATED PREDICTION GRAPH



## **2.1 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 1 and 2 shows it.

The SNDVI graph generate by ANN model indicate that meteorological drought appears in the Bhopal region in a random fashion. From graph 1the negative bars in years 2002-03, 03-04,05-06,08-09, show over all poor vegetation condition in these years, while 2002-03 depict extremely dry condition and remaining years show mild meteorological drought occurrence. The positive bars in years 09-10, 10-11, 11-12 show that good vegetation condition. Higher positive values indicate to good vegetation.

Similarly from prediction graph 2 the negative bars in years 2012-13, 15-16, 18-19, show poor vegetation condition occurrencein these years. The positive bars in years 19-20, 20-21, 21-22 show that good vegetation condition. It is observe that the actual result is very close to the predicted result in concerned area.

#### REFERENCES

- Bankert, R. L.: Cloud classification of AVHRR Imagery in maritime regions using a probabilistic neural network, J. Appl. Meteorol., 33(1994) pp 909 – 918.
- [2]. Crippen, Robert E.: Calculates the vegetation index faster. Remote Sensing of Environment, 34(1) (1990) pp 71 73
- [3]. Marzban, C. and Stumpf, G. J.: A neural network for tornado prediction based on Doppler radar-derived attributes. J. Appl. Meteor., 35, (1996) pp 617–626.
- [4]. Mu"ller, B., and Reinhardt, J.: Neural Networks: An Introduction, the Physics of Neural Networks Series, Springer-Verlag, 2(1991) pp 266.
- [5]. Sellers, P. J.: Canopy reflectance, photosynthesis and transpiration, International Journal of Remote Sensing, 6: 8(1985) pp 1335 — 1372.