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Development and Analysis of Standardized Precipitation Index, Reconnaissance Drought Index and Fuzzy Logic Drought Index for Sabarkantha, Gujarat

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Abstract: ***Drought is a natural disaster which affects any area of planet for months or years. People related to water management often attempt to answer the question of severity of a particular drought.***
When such indicators are identified, the water engineer can formulate the plan and can mitigate the damage of the drought to decide decisions on the future horizon.
This paper is aims to build a SPI, RDI and FLDI model using the concept of fuzzy logic in "Matlab" software to get an idea of years been affected by severity of drought and thus, the actions to be carried out on the basis of a degree of severity. Under this paper three Fuzzy Logic Drought Index (FLDI) Models have been prepared considering three hydro-meteorological data 'Rainfall', 'Temperature' and Potential evapotranspiration'.
Keywords: Rainfall, Temperature, Potential evapotranspiration, Standardized Precipitation Index, Reconnaissance Drought Index, Fuzzy logic, DrinC.

I. INTRODUCTION

Drought is a natural disaster that has disastrous impact on the world economy, environment, industry and community. Thus, drought assessment which is the process of analyzing spatial and historical water related data in drought evaluation is done by water engineer by using several drought index that engrosses various water related standards such as precipitation, evaporation, runoff, etc. in the form of number and makes decisions in quantitative unit for drought evaluation.

II. NEED OF THE STUDY

Drought is a natural disaster which affects any area for any time period. It relates to a lack of long-term rainfall resulting in lack of water for various purposes such as household use, commercial use, environmental sector etc. The aspect of the drought severity using the concept of fuzzy logic, a water engineer can formulate the plan and can mitigate the damage of the drought to take necessary decisions on the future horizon.

III. OBJECTIVES

A. The objectives of study are

1) To develop Fuzzy Logic Drought Index (FLDI) Model considering hydro- meteorological data Rainfall, Temperature and Potential Evapotranspiration as input variables and Drought index as output variable.

2) To develop Fuzzy Logic Drought Index (FLDI) Model considering hydro- meteorological data Rainfall and Temperature as input variables and Drought index as output variable.

3) To develop Fuzzy Logic Drought Index (FLDI) Model considering hydro- meteorological data Rainfall and Potential Evapotranspiration as input variables and Drought index as output variable.

4) To analyze the Fuzzy Logic Drought Index (FLDI) Models for different severity of drought.

5) To determine best Fuzzy Logic Drought Index for the study area.

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IV. LITERATURE REVIEW

A. Lunagaria N.A. and Suryanarayana T.M.V. (2015)
Examined drought in Sabarkantha District using Reconnaissance drought index. They used DrinC software for RDI.

B. Malakiya A.D. and Suryanarayana T.M.V. (2013)
Done Assessment of drought using Standard Precipitation Index and Reconnaissance drought index of Amreli District.

C. Mohseen. K.A.A.(2009)
He done drought index assessment for Fatha region using fuzzy logic approach.

D. Eierdanz. F., Alcamo.J., Acosta- Michlik.L., kronker .D. , Tanzler. D. (2008)
Due to Regional environmental changes, they used fuzzy set theory to address the uncertainty of suspectibility to drought.

E. Agnew C.F. (2000)
Identify the Drought for its assessment by using the Standard Precipitation Index.

V.METHODOLOGY

In this study, Fuzzy logic has been used for the assessment of the drought for the Sabarkantha district. The study is confined to development of SPI, RDI and fuzzy logic drought index models (FLDI) for drought determination in Sabarkantha District in North-East of Gujarat state of India from period 1901-2002. Three Fuzzy Logic Drought Index (FLDI) models are prepared considering three input variables such as rainfall, temperature and potential evapotranspiration and drought index as an output variable. The results of each models are compared with annual SPI and RDI. The result of SPI and RDI are determined by using DrinC software. The results for each drought fuzzy logic model may be presented that allows direct comparison of drought severity for specific periods of the year.

VI. STUDY AREA

The district derives its name from the Sabarmati river that separates Sabarkantha from the neighbouring districts. The district is bounded by the Rajasthan State to the north, Banaskantha and Mehsana districts to the west, Gandhinagar, Kheda, and Panchmahal districts to the south. It is a border district in the eastern part of the Gujarat and is situated between 23-03'32" and 24-29'40" North latitudes and 72-43'34" and 73-39'26" East longitudes, covered by toposheets no. 45D, H, 46A and E of survey of Index.

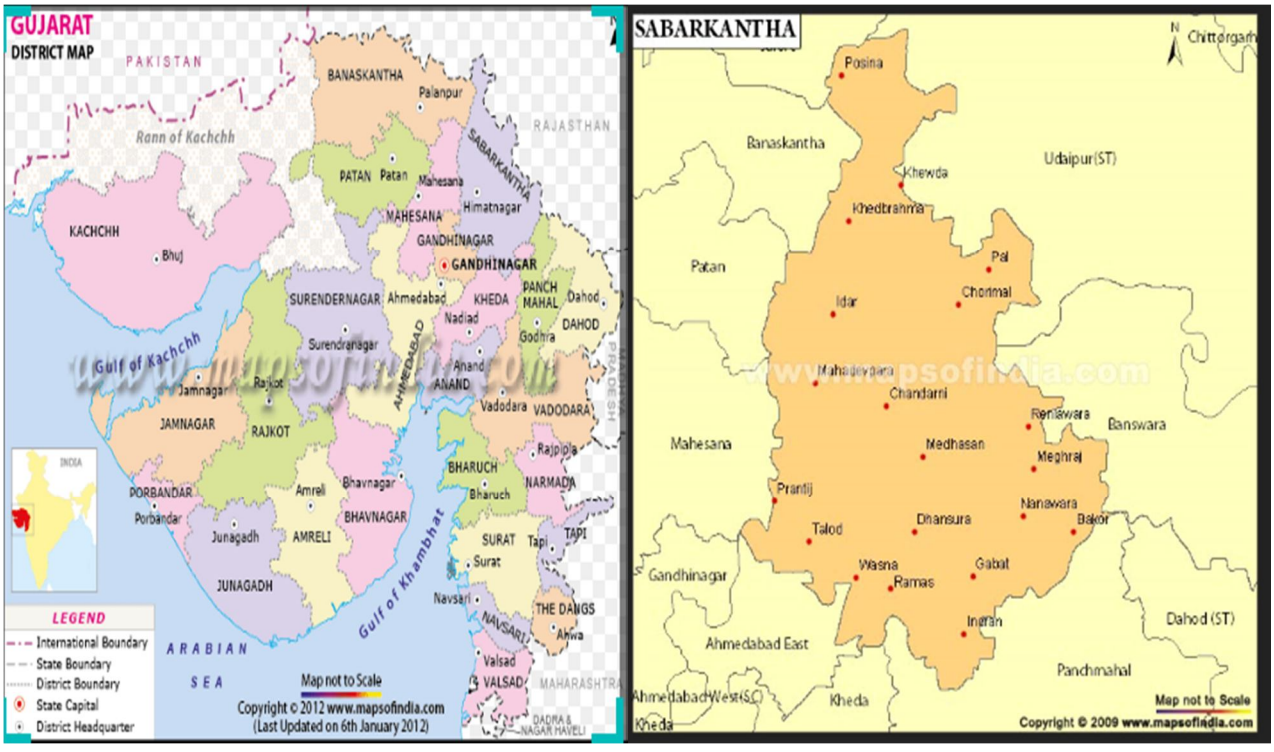


Figure 1- Location of sabarkantha district

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VII. RESULT AND ANALYSIS

A. *Result for SPI*

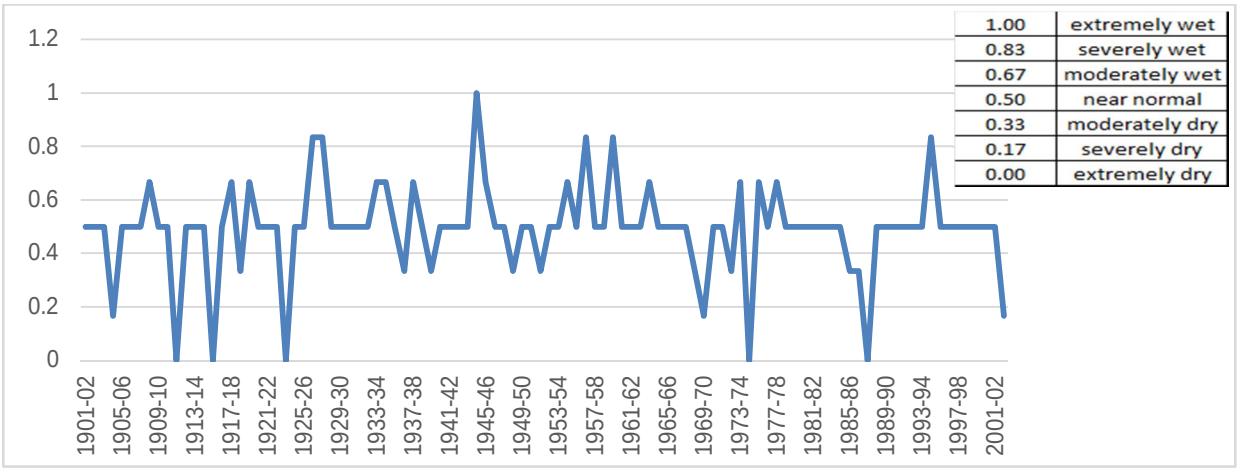


Figure 2- Severity of drought based on SPI for period 1901-2002

It is clearly seen from the above Fig.6.1 that Sabarkantha district faced extremely dry severity of Drought during years 1911, 1915,1923,1974 and 1987. Severely dry severity of drought has been observed during years 1904,1969 and 2002.

B. *Result for RDI*

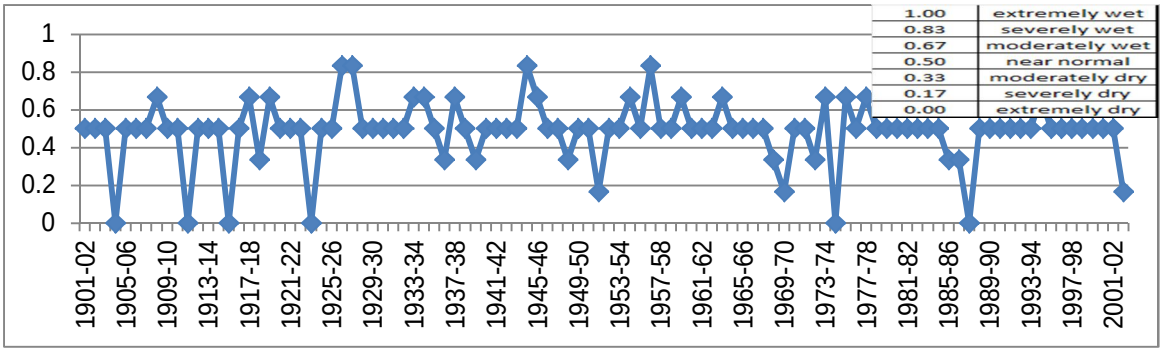


Figure 3- Severity of drought based on RDI for period 1901-2002

It is clearly seen from the above Fig.6.2 that Sabarkantha district faced extremely dry severity of Drought during years 1904,1911,1915,1923,1974 and 1987. Severely dry severity of drought has been observed during years 1951,1969 and 2002.

C. *Result for FLDI Model 1*

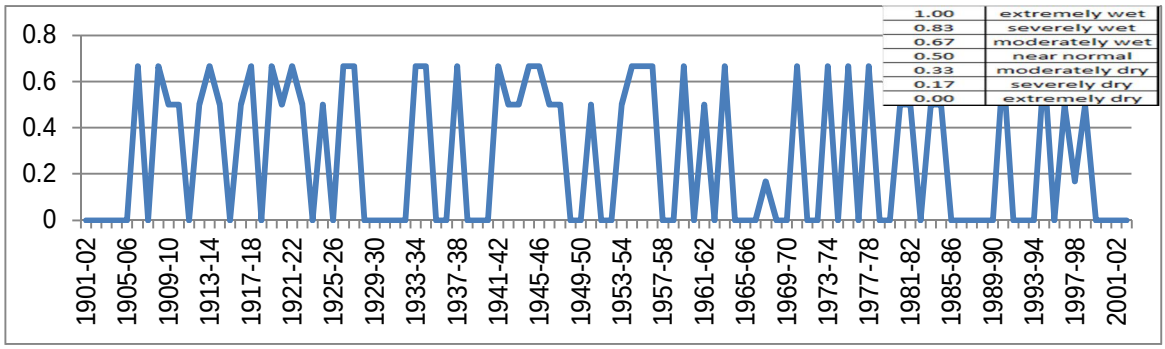


Figure 4- Severity of drought based on FLDI model 1 for period 1901-2002

It is clearly seen from the above Fig.6.8 that Sabarkantha district faced no extremely dry severity of Drought by this Fuzzy Logic Drought Index (FLDI) Model 1. Severely dry severity of drought has been observed during years 1967,1997.

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D. Result for FLDI Model 2

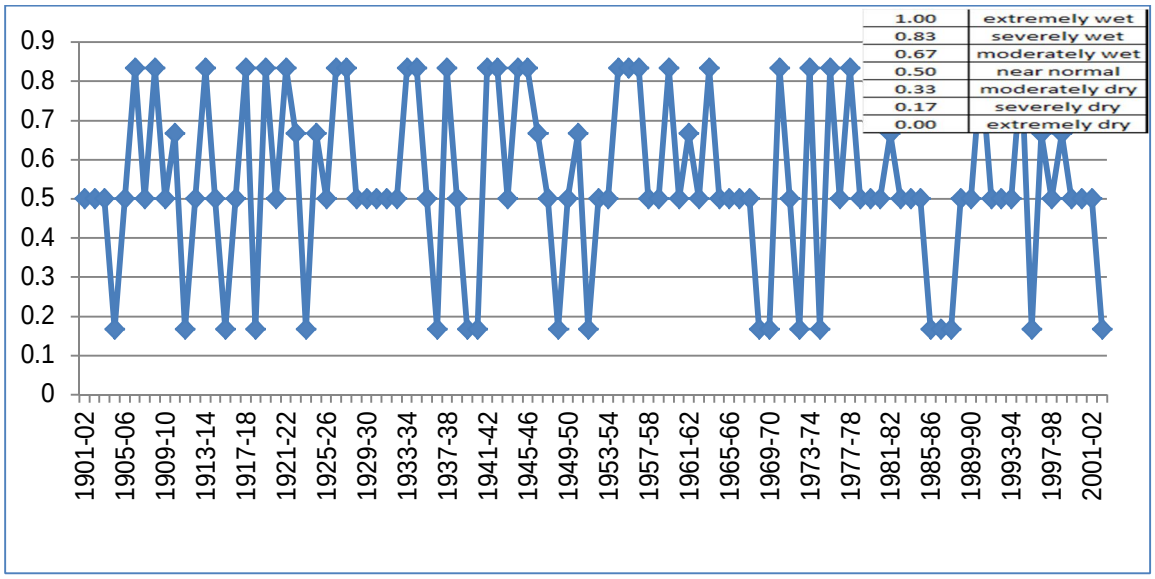


Figure 5- Severity of drought based on FLDI Model 2 for period 1901-2002

It is clearly seen from the above Fig.6.10 that Sabarkantha district faced no extremely dry severity of Drought by this Fuzzy Logic Drought Index (FLDI) Model 2. Severely dry severity of drought has been observed during years 1969, 1972, 1974, 1985, 1986, 1987, 1995, 2002.

E. Result for FLDI Model 3

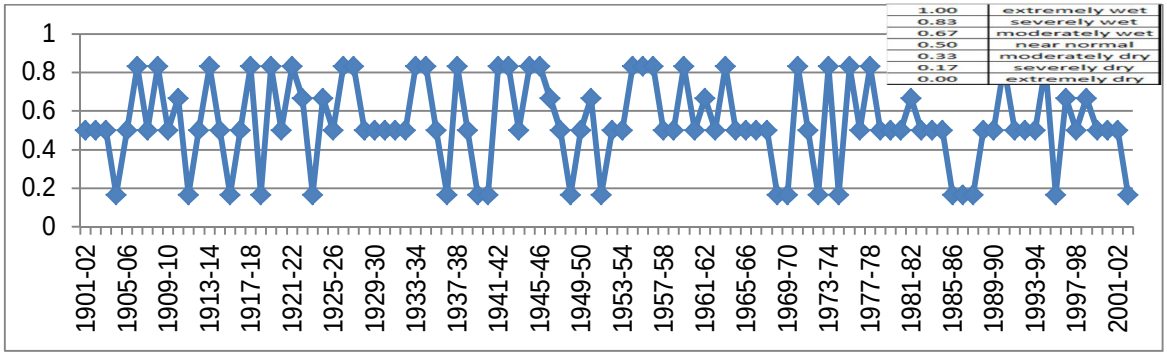


Figure 6- Severity of drought based on FLDI Model 3 for period 1901-2002

It is clearly seen from the above Fig.6.12 that Sabarkantha district faced no extremely dry severity of Drought by this Fuzzy Logic Drought Index (FLDI) Model 3. Severely dry severity of droughthasbeen observed during years 1904, 1911, 1915, 1918, 1923, 1936, 1939, 1940, 1948, 1951, 1968, 1969, 1972, 1974,1985,1986,1987,1995,2002.

VIII. CONCLUSION

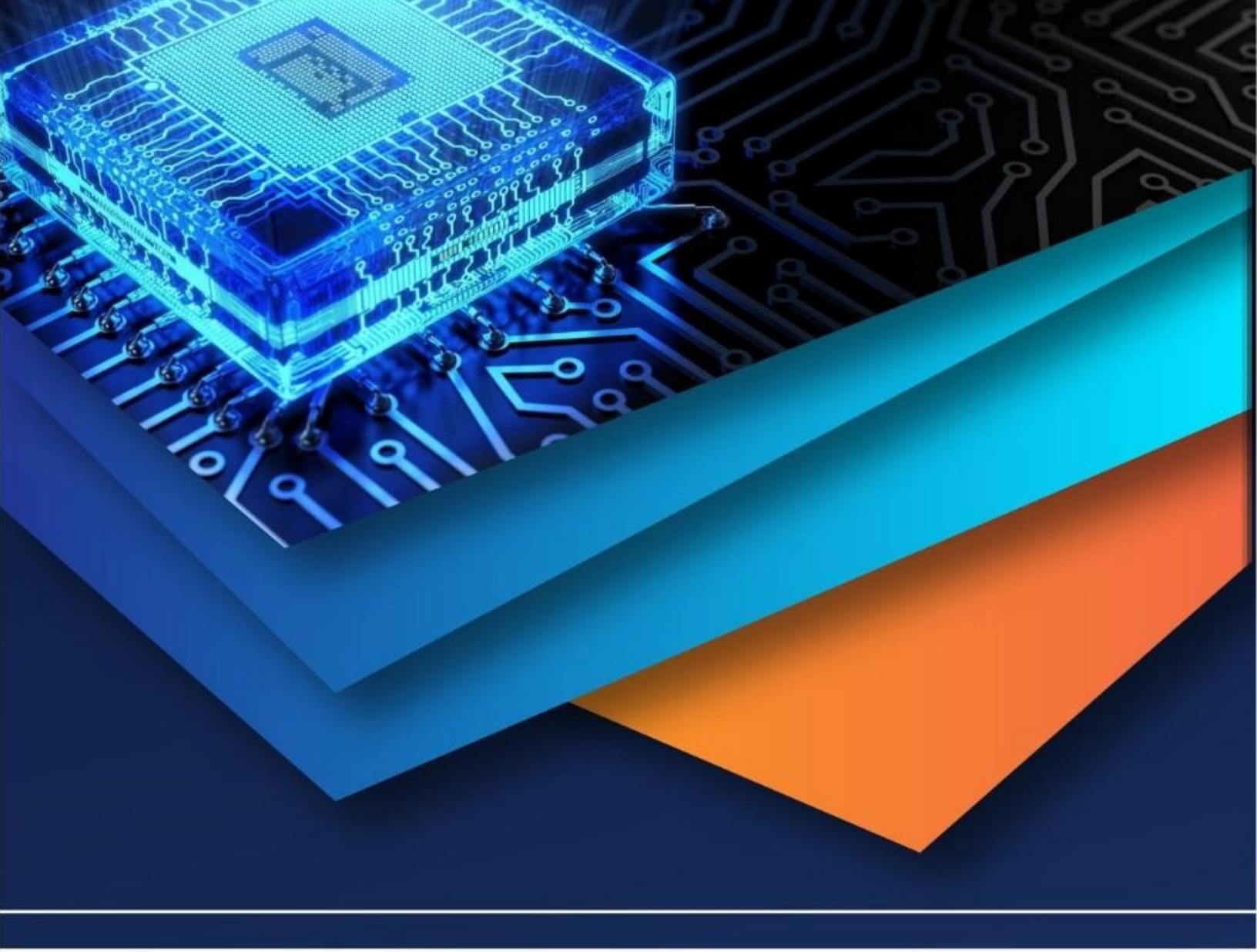
Fuzzy Logic Drought Index (FLDI) Model 1 is prepared considering 'Rainfall', 'Temperature', and 'Potential evapotranspiration' as input variables and 'Drought Index' as an output variable. In this first model, 38% and 41% output of model are matched with the output of annual SPI and RDI respectively. Fuzzy Logic Drought Index (FLDI) Model 2, two hydro-meteorological input variables 'Rainfall' and 'Temperature' are used as input variable and 'Drought Index' as an output variable. In this second model, 56% and 55% output of model are matched with the output of annual SPI and RDI respectively. Fuzzy Logic Drought Index (FLDI) Model 3, two hydro-meteorological input variables 'Rainfall' and 'Potential evapotranspiration' are used as input variable and 'Drought Index' as an output variable. In this third model, 56% and 55% output of model are matched with the output of annual SPI and RDI respectively . Thus, from above observations it is thus concluded that, it is preferable to use Fuzzy Logic Drought Index (FLDI) Model 2 which consider rainfall and temperature as input variables for fuzzy logic drought index (FLDI) determination.

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