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Research Article

Analyzing The Inflow And Outflow Of Water In Mettur Dam Using Fuzzy Time Series

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ABSTRACT

Farming is said to play a leading role in present day situation. The crucial part for forming is water. So, the water for farming in the Cauvery delta areas is routinely got from the mettur dam. Here, we are studying water inflow and outflow by Fuzzy time series, Fuzzy time series was acquainted in nearly 1990's to handle uncertainty data. Fuzzy time series model cannot deal with incomplete data. So here we present the complete inflow and outflow of water in mettur dam for continuous years and develop the algorithm using fuzzy time series and also compute the graphical representation of water inflow and outflow .Using proposed algorithm we also predict the inflow and inflow of water for the future.

Keywords: Fuzzy sets, Fuzzy logic, Fuzzy time series, Inflow of water, Outflow of water.

1.INTRODUCTION

Water plays a major role in agriculture sector; a major source of water for agriculture is from the dams. In Cauvery delta areas Mettur dam plays a predominant role in supply of water for agriculture. Mettur dam was supposed to be storing place of water for agriculture if sufficient quantity of water is not released for agriculture there arises great crisis in agriculture sector. Fuzzy time series model is being applied here for prediction of inflow of water .Fuzzy was first introduced by Zadeh in 1965[1],following that many concepts have been developed in fuzzy by various peoples. In current situation forecasting plays a important role in all places. Forecasting is something where we can predict about future outcomes.

Chen [5] has proposed a fuzzy time series model in forecasting of students enlistment in Alabama University. Chen and Chung [2] also proposed fuzzy logic problems for problems related to forecasting. Huarng and Yu[3] used proportion premised duration of meantime to enhance forecasting perfection, digital fuzzy time series analysis depending on disorder and fast fourier transform was given by Chen and Chung[4].

2. FUZZY TIME SERIES

The rudimentary notions associated to fuzzy time series are constituted as follows

Definition 2.1.

The fuzzy time series be denoted as $G(r),(r =,\ldots,0,1,2,\ldots)$ and $r_1 \neq r_2$ .There exists $g_i(r_2)\in G(r_2)$ for any $g_i(r_1)\in G(r_1)$ and There exists $g_i(r_1)\in G(r_1)$ for any $g_i(r_2)\in G(r_2)$, define $G(r_1)=G(r_2)$ [6-8].

Definition 2.2.

A fuzzy affinity $S_{ij}(r,r-1)$ and $g_i(r-1)\in G(r-1)$, $i\in R$ subsist for any $g_j(r)\in G(r)$ [6-8].Such that $g_j(r)=g_i(r-1)\circ S_{ij}(r,r-1)$,let $S(r,r-1)=\bigcup_{i,j} S_{ij}^2(r,r-1)$ then $S(r,r-1)$ is said to be fuzzy affinity allying $G(r)$ and $G(r-1)$ given by

$$G(r)=G(r-1)\circ S(r,r-1) \qquad (1)$$

Definition 2.3.

Let U indicate the universe of discourse $U=\{u_1,u_2,u_3,\ldots,u_n\}$. In U , a fuzzy set A_i is interpreted as [6-8]

$$A_i = g_{A_i}(u_1)/u_1 + g_{A_i}(u_2)/u_2 + g_{A_i}(u_3)/u_3 + \ldots + g_{A_i}(u_n)/u_n \qquad (2)$$

The grade of membership of u_j is $g_{A_i}(u_j)$ in the fuzzy set A_i and $1 \le j \le n, 1 \le i \le n$. $g_{A_i} : U \to [0,1]$.

Definition. 2.4.

Let $X(r)$ $(r = 0,1,2,...)$be universe of discourse , $g_i(r)(i = 1,2,3,...)$ are fuzzy sets elucidated in $X(r)$.The accumulation of $g_i(r)(i = 1,2,3,...)$ is designated as $G(r)$. $G(r)$ is a fuzzy time series on $X(r)$ [6-8].

Definition. 2.5.

Suppose $G(r-1) = A_i$ and $G(r) = A_j$ where they are said to be fuzzy sets. Let $A_i \to A_j$ indicates the fuzzy logic relationship between $G(r-1)$ and $G(r)$, A_i and A_j are left hand side and right hand side of the fuzzy logical relationship [6-8].

Definition. 2.6.

If $G(r-n) = A_{in},...,G(r-2) = A_{i2}, G(r-1) = A_{i1}$ and $G(r) = A_j$,where $A_{in},...,A_{i2}, A_{i1}$ and A_j are fuzzy sets, then fuzzy logical relationship of nth order can be specified as $A_{in},...,A_{i2}, A_{i1} \to A_j$ [6-8].

3. FUZZY TIME SERIES FORECASTING ALGORITHM

Step 1:

The universe of discourse is contemplated as $R = [S_{\min} - S_1, S_{\max} + S_1]$ into period of identical stretch, here $S_{\min}$ & $S_{\max}$ are maximum and minimum values of the data, we divide R into equal intervals of length n .

Step 2:

The universe of discourse are calculated as $[\mu - 3\sigma, \mu + 3\sigma]$,Here μ refers to mean of the data and σ refers to the volatility of the data. Then calculate the universe of discourse and split them into n period of identical stretch.

Step 3:

Now in fuzzy sets we specify the linguistic terms as given below

$$A_1 = \frac{1}{r_1} + \frac{0.5}{r_2} + \frac{0}{r_3} + \frac{0}{r_4} + \frac{0}{r_5} + \frac{0}{r_6} + \frac{0}{r_7} + \frac{0}{r_8}$$

$$A_2 = \frac{0.5}{r_1} + \frac{1}{r_2} + \frac{0.5}{r_3} + \frac{0}{r_4} + \frac{0}{r_5} + \frac{0}{r_6} + \frac{0}{r_7} + \frac{0}{r_8}$$

$$A_3 = \frac{0}{r_1} + \frac{0.5}{r_2} + \frac{1}{r_3} + \frac{0.5}{r_4} + \frac{0}{r_5} + \frac{0}{r_6} + \frac{0}{r_7} + \frac{0}{r_8}$$

$$A_4 = \frac{0}{r_1} + \frac{0}{r_2} + \frac{0.5}{r_3} + \frac{1}{r_4} + \frac{0.5}{r_5} + \frac{0}{r_6} + \frac{0}{r_7} + \frac{0}{r_8}$$

$$A_5 = \frac{0}{r_1} + \frac{0}{r_2} + \frac{0}{r_3} + \frac{0.5}{r_4} + \frac{1}{r_5} + \frac{0.5}{r_6} + \frac{0}{r_7} + \frac{0}{r_8}$$

....

....

$$A_8 = \frac{0}{r_1} + \frac{0}{r_2} + \frac{0}{r_3} + \frac{0}{r_4} + \frac{0}{r_5} + \frac{0}{r_6} + \frac{0.5}{r_7} + \frac{1}{r_8}$$

Here $A_{1,} A_{2,} ...A_8$ are the linguistic terms.

Step 4:

The fuzzified data in i[th] year is A_j , the two states fuzzy logical relationship is prescribed as $A_j \to A_k$.The uttermost value of fuzzy set A_k transpire in the interval t_k .

The anticipated value of the $(i+1)^{th}$ data is the midpoint md_k of the period t_k .

Step 5:

Forecasting guidelines

Length of the interval t_j is denoted as l_j .

Upper value of the interval t_j is denoted as UP_j .

Lower value of the interval t_j is denoted as LW_j.

C_n denotes the n[th] state value.

C_{n-1} denotes the (n-1)[th] state value.

C_{n-2} denotes the(n-2)[th] state value.

FC_j denotes the forecasted value of the contemporary state j.

Computational Algorithm

We compute algorithm for the given data and obtain fuzzy logical relation

a. $T_n = |(C_n - 2C_{n-1} + C_{n-2})|$

b. i) if $md_j + T_n/4 \geq LW_k$ & $md_j + T_n/4 \leq UP_k$ then $N = N + md_j + T_n/4, y = y+1$

ii) if $md_j - T_n/4 \geq LW_k$ & $md_j - T_n/4 \leq UP_k$ then $N = N + md_j - T_n/4, y = y+1$

iii) if $md_j + T_n/2 \geq LW_k$ & $md_j + T_n/2 \leq UP_k$ then $N = N + md_j + T_n/2, y = y+1$

iv) if $md_j - T_n/2 \geq LW_k$ & $md_j - T_n/2 \leq UP_k$ then $N = N + md_j - T_n/2, y = y+1$

v) if $md_j + T_n \geq LW_k$ & $md_j + T_n \leq UP_k$ then $N = N + md_j + T_n, y = y+1$

vi) if $md_j - T_n \geq LW_k$ & $md_j - T_n \leq UP_k$ then $N = N + md_j - T_n, y = y+1$

vii) if $md_j + 2T_n \geq LW_k$ & $md_j + 2T_n \leq UP_k$ then $N = N + md_j + 2T_n, y = y+1$

viii) if $md_j - 2T_n \geq LW_k$ & $md_j - 2T_n \leq UP_k$ then $N = N + md_j - 2T_n, y = y+1$

c. $FC_j = (N + md_k)/ y + 1$

Next i

4. SIMULATION STUDY

We analyze the inflow of water in mettur dam [9] during the month of January 2007 and formulated the fuzzy set, fuzzy logic relationship. Then the we calculate the forecasted value and forecasted error from the observed inflow data.

S.NO	Inflow of water
1	1162
2	1062
3	1108
4	1059
5	1046
6	937
7	973
8	1035
9	869
10	539
11	579
12	632
13	530
14	591
15	495
16	556
17	500
18	496
19	457
20	450
21	352
22	362
23	360
24	252
25	270
26	355

27	320
28	384
29	389
30	260
31	312

Table1:Inflow of water in Mettur dam in January 2007

S.NO	Observed Value	Fuzzy set	Fuzzy logical relation ship
1	1162	A_6	-
2	1062	A_6	$A_6 \to A_6$
3	1108	A_6	$A_6 \to A_6$
4	1059	A_6	$A_6 \to A_6$
5	1046	A_6	$A_6 \to A_6$
6	937	A_5	$A_6 \to A_5$
7	973	A_5	$A_5 \to A_5$
8	1035	A_6	$A_5 \to A_6$
9	869	A_4	$A_6 \to A_4$
10	539	A_2	$A_4 \to A_2$
11	579	A_3	$A_2 \to A_3$
12	632	A_3	$A_3 \to A_3$
13	530	A_2	$A_3 \to A_2$
14	591	A_3	$A_2 \to A_3$
15	495	A_2	$A_3 \to A_2$
16	556	A_2	$A_2 \to A_2$
17	500	A_2	$A_2 \to A_2$
18	496	A_2	$A_2 \to A_2$
19	457	A_2	$A_2 \to A_2$
20	450	A_2	$A_2 \to A_2$
21	352	A_1	$A_2 \to A_1$
22	362	A_1	$A_1 \to A_1$
23	360	A_1	$A_1 \to A_1$
24	252	A_1	$A_1 \to A_1$
25	270	A_1	$A_1 \to A_1$
26	355	A_1	$A_1 \to A_1$
27	320	A_1	$A_1 \to A_1$
28	384	A_1	$A_1 \to A_1$
29	389	A_1	$A_1 \to A_1$
30	260	A_1	$A_1 \to A_1$
31	312	A_1	$A_1 \to A_1$

Table2:Fuzzy set value and fuzzy logic relationship for inflow of water in Mettur dam in January 2007

$$Mean\ Square\ Error = \frac{\sum_{i=1}^{n} \left| forecasted\ value_i - observed\ value_i \right|^2}{n}$$

$$Forecasting\ Error\ in\ percentage = \frac{\left| Forecasted\ value - observed\ value \right|}{observed\ value} * 100$$

$$Average\ Forecasting\ Error = \frac{Sum\ of\ forecasting\ error}{number\ of\ errors}$$

S.NO	Observed Value	Forecasted Value	Forecasted Error
1	1162	1109	0.044256
2	1062	1109	0.000903
3	1108	1109	0.047214
4	1059	1109	0.060229
5	1046	1031	0.10032
6	937	953	0.020555
7	973	1031	0.003865
8	1035	953	0.096663
9	869	641	0.189239
10	539	563	0.027634
11	579	641	0.014241
12	632	563	0.062264
13	530	563	0.047377
14	591	563	0.137374
15	495	484	0.129496
16	556	484	0.032
17	500	484	0.024194
18	496	484	0.059081
19	457	484	0.075556
20	450	406	0.153409
21	352	328	0.093923
22	362	328	0.088889
23	360	328	0.301587
24	252	328	0.214815
25	270	328	0.076056
26	355	328	0.025
27	320	328	0.145833
28	384	328	0.156812
29	389	328	0.261538
30	260	328	0.051282
31	312	1109	0.044256

Table2:Fuzzy set value and fuzzy logic relationship for inflow of water in Mettur dam in January 2007

Thus from the table 3 we get the average forecasting value ,Mean square error and Average forecasted error
Thus Mean square error = 2466.452
Average forecasted error = 9%

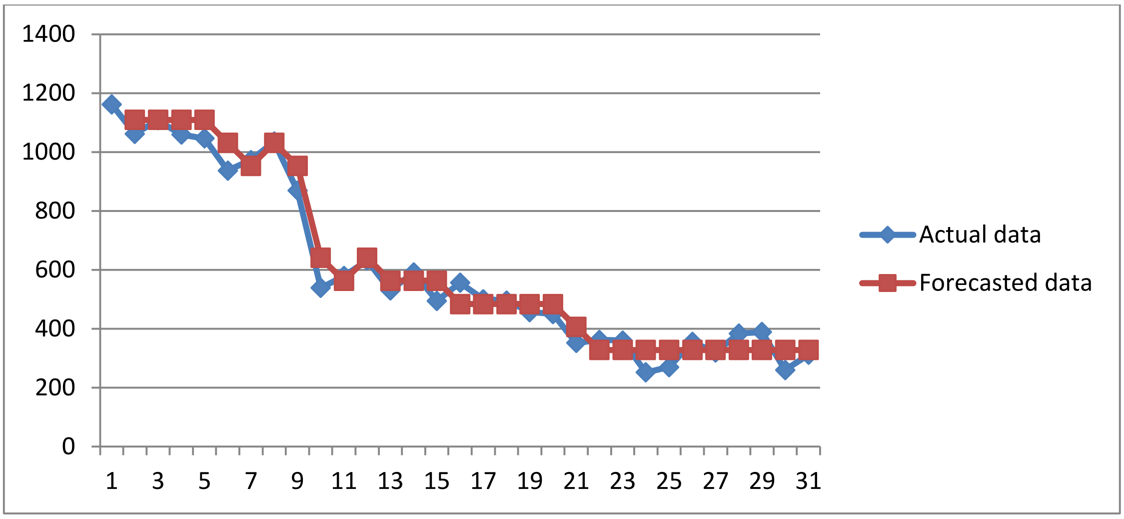

Figure1. Comparison of Actual data and Forecasted Data

5. CONCLUSION

we have collected the water inflow in mettur dam during January 2007 but it is observed the inflow of water is not sufficient for agriculture but the forecasted data will enable to predict the sufficient quantity of water required for agriculture, in the similar way we can predict the required quantity of outflow of water. Thus if the inflow and outflow of water are in the appropriate quantity every year there will be no deficiency of water for agriculture sector.The Forecasting error is also being calculated for the inflow of data. The graphical representation of the actual data and forecasted data are also represented in the paper.

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