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Advanced Technique of Fuzzy Logic Algorithm Based Assessment of Periodic Variation of Water Quality of Nethravathi River in Dakshina Kannada District

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Abstract:
The decision-making using comparison of stream water quality prescribed limits with various water quality indices has been developed to integrate water quality variables. This approach has few drawbacks such as some parameters in the index equations can influence the final score of WQI dramatically without valid scientific justification. There are limitations on which a wrong decision can be taken as it is dependent on the fix weight age assigned to different parameters, where as the weight age should be varied on the basis of season, rainfall, ambient temperature and other environmental factors. These indices are lacking to deal with uncertainties involved at various steps indecision-making. One way of avoiding the difficulty in uncertainty handling in water quality assessment is to introduce a margin of safety or degree of precaution before applying a single value to quality standards as the same technique was also used by other workers in the field of environmental sciences. These methodologies based on fuzzy sets theory are tested with real environmental problems to handle the uncertainty in imprecise environment in decision-making tools. It is proposed that methods based on fuzzy sets theory can be applied to deal with the uncertainties in the decision-making on the stream water quality, keeping the importance of uncertainty handling in the water quality assessment and versatility of the fuzzy set theory in the decision-making in the imprecise environment. In this project, we propose the fuzzy set theory for decision-making in the assessment of physico-chemical quality of Nethravathi River of Dakshina Kannada, Karnataka.

Keywords: Fuzzy logic; Membership; Linguistic variable; Fuzzification

I. INTRODUCTION

Mangalore coast is at stretch of 22 Kms of the Western Ghats of the Indian peninsula region. This area receives huge quantity of pollution load from the major industries, factories, hotels etc located nearby. This pollution load is then discharged into the sea either directly or through the major flowing rivers of the region such as Nethravathi and Gurupura [2]. The pollution load includes runoff of the sediment, waste from oil refineries, pesticides and iron ore residues from the nearby iron Ore Company and chemicals from the chemical industries. The distortion of the quality of water occurs because of the increase in the municipal waste and huge waste of sewage that will be thrown into the sea and river [5]. The water quality is considered as the most prominent issues at the global level which include social, political and environmental issues. The challenge for environmental engineers is to monitor the quality of water and decision-making in qualitative and quantitative on the information provided on the data base from every step of sampling in order to analyze the uncertainties. The pollutant or contaminants have certain regulatory limits for which the Bureau of Indian Standards, World. Health Organization and Indian Council of Medical Research have created positive boundaries [6]. In order to determine the necessary information or guidelines the data on the status and the varying trend these guidelines have to be followed. Well-organized completion for quality assessment, monitoring of water and enforcement action of arranged restrictions by various stream bodies. There are different rules that are been discussed in the prose of the water in stream criterion and decision-making. The maximum information on the quality of water has exposed the deterministic move toward in decision-makings is by comparison of the values of parameter of water quality with agreed restrictions. By evaluating the quality of stream water arranged limits with the water quality indices for various streams in decision making has become a development to incorporate quality of water variable [8]. This further approach has been encountered with certain drawbacks such as it can influence some of the equations in the parameters of the index by which the final value of the water quality index can be obtained considerably without much valid technical reason. The false result has certain limitation due to which the decisions are taken based on the certain fixed and assigned weight age to the different values of parameters [12]. These types of index are deficient in to contract with reservations concerned at a variety of steps in decision-making. Because of this restriction of Water Quality Index draw near and deterministic a complex arrangement scheme is needed. The judgment taken on the quality of water of stream assessment has been determined that The Water is Desirable, acceptable and not acceptable as per them guidelines From various regulatory body inputs. It has even become a Herculean task as there are different types of uncertainties which are involved at different part of investigational and dimensional procedure

which begins from sample storage, processing , sampling and analysis [9].

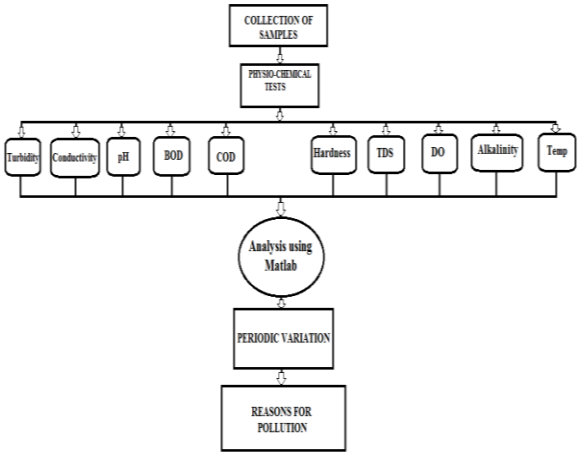
II. BIRTH OF FUZZY AND FUZZY CONCEPTS

The algorithm of fuzzy logic has been used to access the quality of water by using the index of water quality which is on Fuzzy type 2 investigation. The formula process of maps from. the determinant input to the determinant output of the reasoning logic is approved. This is on patterns or maps on which decisions can be taken. It has three most important steps: rules inference, functions of members and the operations of fuzzy set [1]. This comparison will be exact over the conventional method (DOE-WQI). The samples of the water data are taken from the river which can evaluate the samples for the fuzzy type 2 logic algorithm. Here the basic membership of the fuzzy function rule are defined based on the determinants. The model was evaluated with data from October 2016- March 2017 of Nethravathi river basin based on fuzzy algorithm type 2 inference system. The model of fuzzy has been invented which is on the chemical and physical characteristics[13].

III. STUDY BACKGROUND

Shelton Pinto in his paper entitled "Fuzzy Logic Based Assessment of Periodic Variation of Water Quality of Nethravathi River in Dakshina Kannada District" in the year 2014 has made an attempt to determine the quality of water of Nethravati river in Dakshina Kannada district in the year 2014-2015 conducted by 4 students of Civil Engineering branch from Sahyadri college Mangalore as their final year project. The river water samples were collected from ten different stations of Nethravati river in the year 2014-2015 and were analyzed using physio-chemical tests for 6 different months. The samples were collected from October to March in the year 2014-2015. After the tests were conducted the results were analyzed using Fuzzy technique in Matlab software by conventional method. Based on the inland stream water code limits for different parameters were obtained and designed. The results were obtained in terms of percentage and were easy for a common man to understand. These results were then put together to get a single value. A graph was plotted in order to determine the periodic variation of Water quality of Nethravati River in Dakshina Kannada district.

IV. METHODOLOGY ADOPTED



V. STRETCH OF THE RIVER SELECTED FOR THIS PROJECT

Based on the pollution load the river stretch was selected for a stretch of about 90kms from Ullal to Dharmastala and these locations were selected where maximum pollution takes places so that water quality can be determined based on maximum pollution taking place.

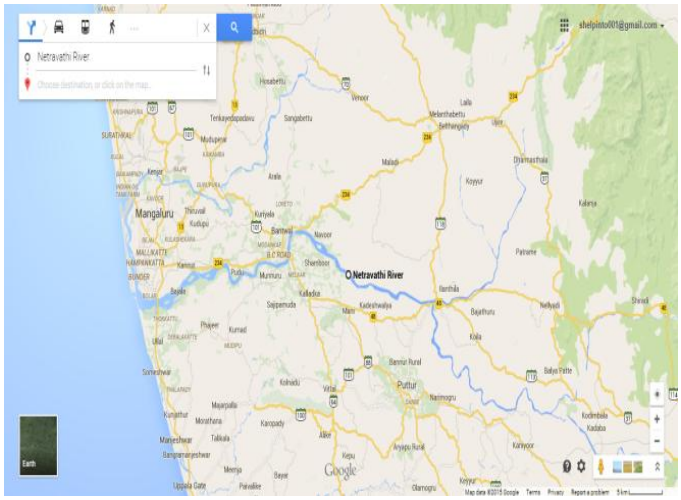


Figure.1. Stretch of the river

VI. OCATIONS SELECTED FOR THE COLLECTION OF SAMPLES

These locations were selected based on the maximum pollution load occurring at different stations in order to get the difference in periodic variation.

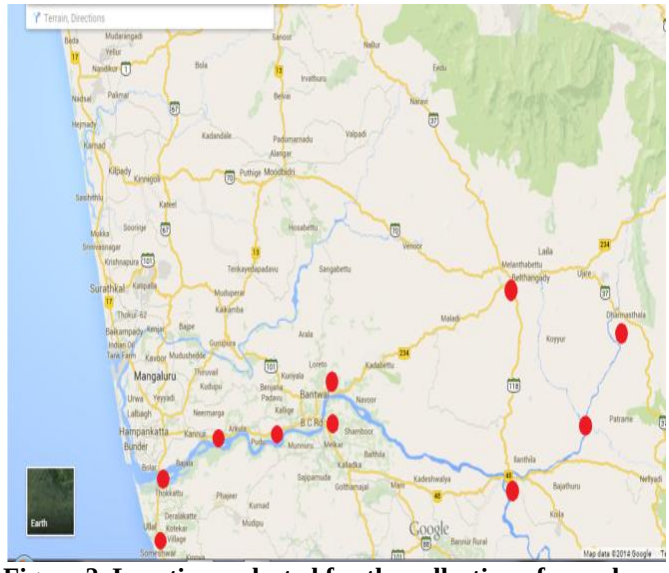


Figure.2. Locations selected for the collection of samples

VII. TESTS RESULTS FROM THE MONTH OF OCTOBER TO MARCH 2016-2017

The tests were conducted on the samples that were collected during the six months for 10 different stations and the test results are mentioned in the figures given below.

TRAIL 1: 22nd OCTOBER 2016

Table 4.1: Test result for the month of October

Tests conducted	Dharmasthala	Southadka	Belthangady	Uppinangady	Panem'lore	Bantwal	Tumbe	Adyar	Nethravati bridge	Kotepura
TURBIDITY(NTU)	18	10.5	13.4	18.6	11.6	36.5	32.5	25.6	28.3	12.1
CONDUCTIVITY(ms)	0.4	0.5	0.6	0.7	0.6	0.6	0.5	0.4	6.2	24.6
pH	7.2	8	7.23	7.56	7.36	7.86	7.73	8.6	6.9	7.1
D.O (mg/lt)	5.2	5.6	6.88	5.3	7.5	5.2	6.3	4.9	5.63	3.2
B.O.D(5 days @ 20°c)(mg/lt)	2.3	1.6	1.15	1.43	1.24	1.75	2.23	2.63	3.63	31.6
C.O.D(mg/lt)	14	29.6	34.6	18.6	26.6	16.2	10.2	44.6	132	245
HARDNESS(mg/lt)	5	6	7	8	10	11	9	25	365	1760
T.D.S(mg/lt)	112	111	96	195	153	154	118	126	4765	19640
ALKALINITY(mg/lt)	156	136	89	170	182	166	124	132	156	256

Figure.3. Tests results for the month of October

TRAIL 2: 23rd NOVEMBER 2016

Table 4.2: Test result for the month of November

Tests conducted	Dharmasthala	Southadka	Belthangady	Uppinanagady	Panem'lore	Bantwal	Tumbe	Adyar	Nethravati bridge	Kotepura
TURBIDITY(NTU)	11.68	9.6	8.5	26.56	7.2	49.3	48.3	36.5	32.6	29.6
CONDUCTIVITY(ms)	0.6	0.5	0.5	0.3	0.8	0.6	0.3	0.4	7.2	16.5
pH	7.23	7.36	7.1	7.68	7.88	8.2	6.6	7.48	7.6	6.85
D.O (mg/lt)	5.23	4.63	7.31	68	7.38	5.2	6.31	6.8	5.55	2.9
B.O.D(5 days @ 20°c)(mg/lt)	2.58	1.3	1.2	1.85	1.3	2.2	1.9	1.81	2.75	38.9
C.O.D(mg/lt)	12.45	26.56	36.56	12.56	25.65	10.65	32.56	46.56	112	325
HARDNESS(mg/lt)	6	10	4	3	14	7	8	12	282	1752
T.D.S(mg/lt)	94	138	83	190	132	186	128	148	5634	18635
ALKALINITY(mg/lt)	125	174	62	198	142	184	162	146	111	231

Figure.4. Tests results for the month of November

TRAIL 3: 29th DECEMBER 2016

Table 4.3: Test result for the month of December

Tests conducted	Dharmasthala	Southadka	Belthangady	Uppinanagady	Panem'lore	Bantwal	Tumbe	Adyar	Nethravati bridge	Kotepura
TURBIDITY(NTU)	1.4	1.1	1.7	0.6	2.5	0.5	0.3	2.3	1.8	2.1
CONDUCTIVITY(ms)	0.4	0.6	0.5	0.4	0.4	0.4	0.4	15	36.5	43.8
pH	4.9	4.9	4.7	5.2	5.2	5.25	5.4	6.25	6.2	7.2
D.O (mg/lt)	5.3	4.4	6.9	6.24	5.13	6.84	6.21	5.84	6.48	1.42
B.O.D(5 days @ 20°c)(mg/lt)	2.3	2.4	1.1	2.18	1.41	1.42	2.4	1.32	2.32	44.56
C.O.D(mg/lt)	23	22	34	10.6	28.9	21.6	36.5	40.2	165	246
HARDNESS(mg/lt)	3	5	11	2	4	4	8	4	286	1562
T.D.S(mg/lt)	158	26	48	5	36	10	244	42	29826	34562
ALKALINITY(mg/lt)	52	60	30	52.5	45	462	45	152	142.4	165

Figure.5. Tests results for the month of December

TRAIL 4: 24nd JANUARY 2017

Table 4.4: Test result for the month of January

Tests conducted	Dharmasthala	Southadka	Belthangady	Uppinanagady	Panem'lore	Bantwal	Tumbe	Adyar	Nethravati bridge	Kotepura
TURBIDITY(NTU)	1.56	1.34	2.3	3.4	5.8	1.2	5.2	4.35	2.36	2.95
CONDUCTIVITY(ms)	0.5	0.6	0.5	0.2	0.3	0.4	0.2	18.3	38.56	35.63
pH	7.65	6.85	3.86	4.9	5.9	5.2	7.2	4.96	6.35	5.36
D.O (mg/lt)	4.23	5.10	6.35	5.6	4.8	5.6	7.3	4.63	6.2	2.45
B.O.D(5 days @ 20°c)(mg/lt)	3.97	4.85	2.21	3.5	2.3	1.6	1.8	3.96	1.6	36.38
C.O.D(mg/lt)	19.2	24.5	30.6	19	26	18	34	46.3	165	243
HARDNESS(mg/lt)	8	16	10	14	3	10	12	9	365	2745
T.D.S(mg/lt)	201	26	44	2	23	9	154	72	14653	48230
ALKALINITY(mg/lt)	60.2	45	56	62	36	664	35	156	268	189

Figure.6. Tests results for the month of January

TRAIL 5: 20th FEBRUARY 2017

Table 4.5: Test result for the month of February

Tests conducted	Dharmasthala	Southadka	Belthangady	Uppinanagady	Panem'lore	Bantwal	Tumbe	Adyar	Nethravati bridge	Kotepura
TURBIDITY(NTU)	3.3	6.4	3.8	6.2	1.9	1.8	2.4	3.1	7.2	8.6
CONDUCTIVITY(ms)	0.5	0.5	0.4	0.6	0.9	0.6	0.6	0.5	28.4	28.63
pH	7.36	6.23	5.5	6.12	5.23	6.2	6.6	5.36	8.63	5.63
D.O (mg/lt)	4.23	5.86	5.6	5.43	6.21	6.5	5.2	7.86	4.35	6.56
B.O.D(5 days @ 20°c)(mg/lt)	4.23	2.2	4.2	2.63	1.54	6.8	4.2	2.6	6.6	32.65
C.O.D(mg/lt)	13.4	31.8	26	17.6	36.5	19	12	48.5	235	340
HARDNESS(mg/lt)	6	6	8	12	12	14	15	20	349	1845
T.D.S(mg/lt)	362	265	348	322	263	350	465	412	1663	23662
ALKALINITY(mg/lt)	110	72	85	36	52	50	62	132	165	152

Figure.7. Tests results for the month of February

TRAIL 6: 12th MARCH 2017

Table 4.6: Tests results for the month of March

Tests conducted	Dharmasthala	Southadka	Belthangady	Uppinanagady	Panem'lore	Bantwal	Tumbe	Adyar	Nethravati bridge	Kotepura
TURBIDITY(NTU)	1.6	1.8	2.4	4.6	1.5	1.2	1.7	3.2	4.1	6.8
CONDUCTIVITY (ms)	0.52	0.34	0.62	0.75	0.6	0.68	0.76	0.69	26.5	36.5
pH	7.23	6.7	6.86	6.43	6.3	5.4	6.22	5.96	7.63	6.25
D.O (mg/lt)	6.8	6	5.2	7.2	6.4	6.3	6.2	6.1	7.1	7.4
B.O.D(5 days @ 20°c)(mg/lt)	3	2.1	6.2	3.2	2.8	1.8	3.4	2.9	7.1	32.56
C.O.D(mg/lt)	8.4	26.5	32.5	22.3	24	18.5	12.9	35.6	186	265
HARDNESS(mg/lt)	7	4	16	18	12	8	26	28	463	2686
T.D.S(mg/lt)	362	284	325	362	385	384	452	396	17625	21663
ALKALINITY (mg/lt)	90	46	65	29	44	55	64	96	159	160

Figure.8. Tests results for the month of March

TOLERANCE LIMITS FOR INLAND SURFACE WATER (IS: 2296-1982)

Based on the IS code these tolerance limit were taken and were used for comparison with the test values which helped in fuzzy analysis to vary the membership functions.

Table.1. Tolerance limits for inland surface

SL NO	CHARACTERISTIC	TOLERANCE LIMIT
1	Ph value	6.5 – 8.5
2	Dissolved Oxygen(mg/l)	4 – 6
3	BOD(5 days at 20°c) mg/l	0 – 30
4	COD (mg/l)	0 – 200
5	Total Dissolved Solids(mg/l)	0 – 1200
6	Hardness (mg/l)	0 - 500

VIII. FUZZY IMPLEMENTATION

The algorithm of the fuzzy coverts the embedded human language into an algorithm that works. When the condition is complex or not understood and when the behavior of the interface is unknown these Fuzzy algorithm can be used. By this outcome the results are formed in a faster way and easier way and they can be guaranteed. This technique is applicable when the interface is difficult to understand. This tool helps and is very important in generic decision making. For example, when the erratic is linguistic. We can say "site conditions". This will take the values such as excellent, fair, poor, etc. The arrangement uttered in different forms and words in the above example has a

certain value but they will not be defined well. All these sets of the fuzzy can be used to for qualitative exposure in order to maintain the quality. But when the level of confidence of the sets of fuzzy will be narrow, the linguistic numerals will be termed as excellent, very fair, very poor, etc and so on. These differences of the linguistic variables can be enumerated then they can be used for the generation of the linguistic description of the core sets of the interface by using the "modifiers".

IX. APPLICATIONS DONE ON THIS PROJECT

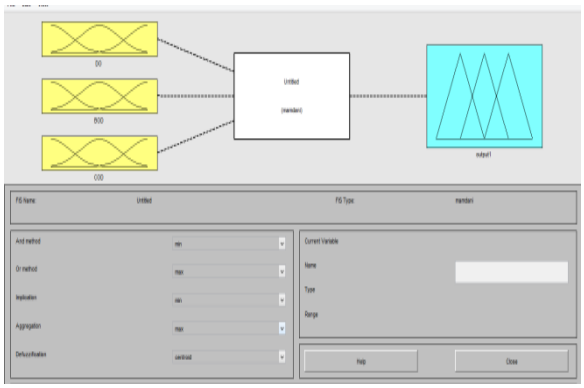


Figure.9. Fuzzy implementation made in this project

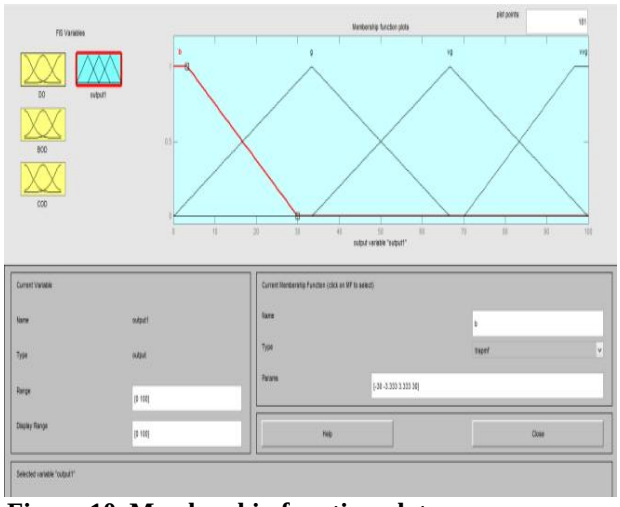


Figure.10. Membership function plots

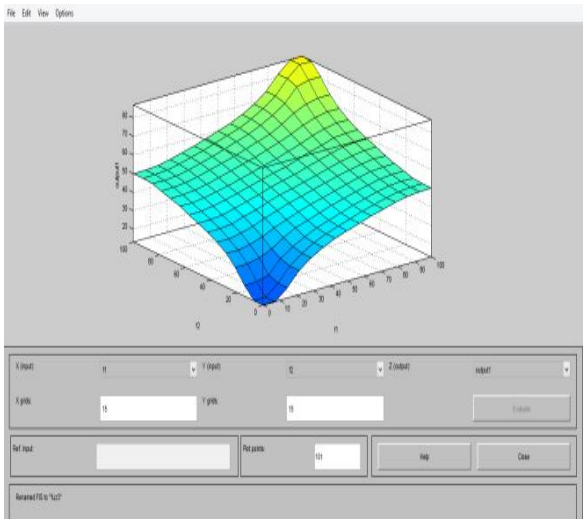


Figure.11. Plot of COD, BOD & DO

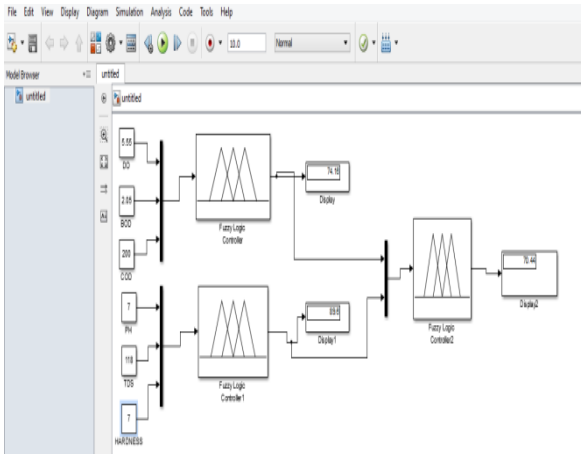


Figure.12. Simulated output

Figure.13. Periodic variation of the quality of water at different stations

X. REASONS FOR THE POLLUTION

The samples were collected from October to March (2016-2017) and there was a drastic change in the water quality and purity. It was found the quality of water decreases to about 40% where the quality is very low. The quality of water at certain stations is up to 80% pure. The pollution load is increased due to the wastes that are let off to the streams without treatments. They consist of small rocks and hard particles and even some rocks emerging out from the water. Near Dharmastala pilgrim center is located and even hundreds Of people Take "Holy dip" and most of the people wash their daily wear along the banks of this river every day. Washing of clothes, cleaning Of Vehicles etc. also take place and are seen on the river stream. Trading centers are located on the banks of the river due to which the water turns highly turbid in the monsoon and they turn brown and muddy and huge unwanted particles are thrown into the river and the suspended particles are increased which pollute the river. In most of the stations river bed consists of silt with different types of pebbles. At certain stations paddy and different agricultural crops are planted all round in. the catchment area of the river bank. People celebrate different festivals which take place annually and attract people from different places. People even use the water for their daily use and pollute it. Schools and colleges situated close to the river let the untreated water directly into stream which causes the death of aquatic life too. The restaurants and small shops let the waste into the stream. At certain locations the fish oil and fish oil wastes are let into the

stream which highly pollute the river. Sand mining is a serious issue that is considered in most of the places in the stretch.

XI. CONCLUSION

Fuzzy type 2 algorithm is termed as the supple tool. By which the categorization model can be developed with an easy structure and natural language can be used to set it up. In the current project study, the water purity was obtained to decide .the periodic variation of current stretch of river so that the assessment of water quality would be understood easily based on the understanding of people. It has been proved that computing with linguistic terms within FIS improves the tolerance for imprecise data. The assessment of variation of quality of river is assessed. Fuzzy algorithm model type 2 has eliminated all the defects and uncertainties that were caused by the conventional which said that quality of water is below sustainable expected results in the Nethravathi River. The fuzzy algorithm type 2 believes in assisting the decision making and in the water quality report conditions which even investigates the temporary change that take place in the river. The algorithm tool and concept if used logically, could be more helpful and successful tool for some of the environmental policy matters. Fuzzy algorithm model based on FIS can be used for future determination. of Water Quality Index for different parameters. More severe methods are used to begin the ideas of the algorithm that can be applied on the Fuzzy algorithm model.

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