Comparative Study on Dissolved Trace Metal Concentrations of Iron and Manganese in Muvattupuzha River

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Abstract *- Various methods have been used for estimating the water quality in river systems. However, there exist uncertainty in the quality criteria employed and the vagueness in the input data and the decision making output values. Fuzzy set theory has been successfully used for the analysis of vague and imprecise information. Fuzzy synthetic evaluation technique applied in [4] is one approach of this type. This paper presents a study on dissolved trace metal concentrations of Fe and Mn in Muvattupuzha river using modified fuzzy synthetic evaluation approach in comparison to the mean and standard deviation methods.*

Keywords - ***fuzzy set, fuzzy synthetic evaluation, modified fuzzy operator.***

1 . INTRODUCTION

Muvattupuzha river is one of the major perennial rivers in Central Kerala having, a length of 121km, a catchment area of 1554km^2, annual sediment load input of 1,57,000 tons and an annual run off of 4780 million m^{3}of fresh water. The agricultural areas and urban township located on the river banks of Muvattupuzha discharge untreated agricultural and domestic effluents in to the river. Trace metals get added to the riverine environment from both natural and anthropogenic sources [3]. Data on trace metal partitioning between dissolved and suspended particulate phases are scarce because only a few such measurements have been made in Indian riverine environments. Geo chemical assessment of trace metal enrichment in aquatic sediments is an important component in understanding environmental pollution and its impact on the ecosystem. Since the measurements of this involve vagueness we can suitably apply fuzzy theory for better evaluation.

II. FUZZY SYNTHETIC EVALUATION

The concepts of fuzzy sets describing imprecision or vagueness was introduced by Zadeh in 1965 and has been applied throughout the world in decision making and evaluation process in imprecise environment. Lu et al. (2000) applied fuzzy synthetic evaluation techniques for accounting fuzzy information. Modified fuzzy operator is a simple fuzzy synthetic evaluation tool capable of overcoming the uncertainties existing in the sampling and analysing methods.

III. MODIFIED FUZZY OPERATOR

Modified fuzzy operator method utilizes the max-min operator (Zadeh) as a tool to perform fuzzy synthetic evaluation. If the relationship between ith parameter and jth data is represented by a fuzzy number $\{\lambda ij\}$, then the relative impact is obtained by the interval $(\max_i \min_j \{\lambda ij\}, \min_i \max_j \{\lambda ij\})$

IV. THE BIMONTHLY DATA ON DISSOLVED TRACE METAL Fe AND Mn IN THE WATER COLUMN AT 18 STATIONS OF THE MUVATTUPUZHA RIVER:

Station Position	July		September		November	
	Fe (ppb)	Mn (ppb)	Fe (ppb)	Mn (ppb)	Fe (ppb)	Mn (ppb)
S1	53.55	25.65	57.9	26.55	40.59	21.27
S2	45.95	26.25	58.8	32.57	42.53	25.77
S3	38.85	24.82	48.8	31.97	36.54	25.35
S4	40.88	26.06	53.8	32.65	37.56	25.86
S5	43.35	27.55	69.7	32.09	35.56	25.45
S6	45.95	30.95	65.6	33.34	37.56	26.45
S7	48.45	30.95	61.5	29.22	35.53	23.16
S8	45.98	30.78	53.3	30.09	35.53	23.86
S9	43.35	27.57	43.1	31.37	36.54	24.86
S10	40.88	22.96	44.8	25.27	35.53	20.78
S11	38.25	33.07	34.9	25.86	33.53	20.48
S12	40.88	32.45	42.8	24.45	36.54	20.36
S13	41.85	33.15	32.8	25.67	35.53	20.35
S14	53.55	32.58	44.9	27.17	36.54	21.47
S15	65.85	33.85	39.0	30.48	37.56	24.15
S16	68.88	29.67	36.9	30.48	38.56	24.18
S17	48.45	30.55	57.4	30.38	36.54	24.85
S18	45.85	31.85	51.5	27.15	37.55	21.48

station position	January		March		May	
	Fe (ppb)	Mn (ppb)	Fe (ppb)	Mn (ppb)	Fe (ppb)	Mn (ppb)
S1	40.16	23.87	22.33	14.65	19.29	16.91
S2	34.46	19.95	21.32	17.97	25.38	13.57
S3	29.14	19.66	16.24	17.58	28.42	14.00
S4	30.66	18.59	17.26	17.96	24.51	13.18
S5	38.55	19.53	22.33	17.65	23.50	16.43
S6	34.46	20.61	29.44	18.38	22.48	14.65
S7	36.34	23.18	23.50	16.77	21.47	16.43
S8	34.49	23.21	24.51	16.55	23.50	16.43
S9	32.57	20.42	25.53	17.25	25.53	14.36
S10	30.66	24.74	26.54	13.85	26.54	17.61
S11	28.69	24.34	25.53	14.28	28.59	17.23
S12	30.66	24.82	24.51	13.45	22.63	17.60
S13	31.39	24.43	23.50	14.57	25.68	17.30
S14	40.16	25.39	25.53	14.96	21.32	18.01
S15	49.39	22.23	28.58	16.77	23.05	16.44
S16	51.66	22.90	27.55	16.76	23.05	16.22
S17	36.34	23.86	23.50	16.77	22.48	14.28
S18	34.39	20.62	26.24	14.95	21.47	14.66

V . BIMONTHLY MEAN VALUES AND STANDARD DEVIATION OF DISSOLVED TRACE METAL IN THE WATER COLUMN OF MUVATTUPUZHA RIVER.

Month	dFe (ppb)	dMn (ppb)
July 2005	47.26 ±8.53	29.71± 2.95
Sept 2005	49.84± 10.73	29.27± 2.91
Nov 2005	36.99 ±2.04	23.34± 2.18
Jan 2006	35.45 ±6.39	22.35 ±2.18
Mar 2006	24.11 ±3.44	16.17 ±1.58
May 2006	23.82± 2.48	15.85 ±1.55

Thus the dissolved iron content in water column varies between 16.24 to 69.70ppb and the dissolved iron average is 36.25during the months of July 2005 to may 2006 .The dissolved manganese contents in water column varies between13.18 to 33.85ppb during the months of July 2005 to may 2006 .

The dissolved Mn averages 22.78ppb of the Muvattupuzha river is much higher than the dissolved Mn averages of some other Indian rivers like Cauvery(2.60ppb).The maximum permissible limit of Mn in drinking water is 500ppb as per WHO(1993)and ICMR(1986) where as it is 300ppb as per BIS(1991)standard. The dissolved Mn concentration averages obtained during the study is much lower than the maximum permissible limit for drinking water standards.

VI. EVALUATION OF DISSOLVED TRACE METAL USING MODIFIED FUZZY OPERATOR.

Station Position	July		September		November	
	Fe (ppb)	Mn (ppb)	Fe (ppb)	Mn (ppb)	Fe (ppb)	Mn (ppb)
Min{λij} j	38.25	24.82	32.8	24.45	33.53	20.35
Max{λij} j	68.88	33.85	69.7	33.34	42.53	26.45

Station Position	January		March		May	
	Fe (ppb	Mn (ppb)	Fe (ppb	Mn (ppb)	Fe (ppb	Mn (ppb
Min{λij} j	28.69	18.59	16.24	13.45	19.29	13.18
Max{λij} j	51.66	25.39	29.44	18.38	28.59	18.04

Relative impact of Dissolved Iron

$\max_i \min_j\{\lambda ij\}$ = $\max_i\{38.25,32.8,33.53,28.69, 16.24, 19.29\}$
= 38.25ppb

$\min_i \max_j\{\lambda ij\}$ = $\min_i\{68.88,69.7,42.53,51.66, 29.44, 28.59\}$
= 28.59ppb

The dissolved iron in the Muvattupuzha river ranges from 28.59 to 38.25ppb and the dissolved iron average is 36.25ppb lies in this interval. The dissolved Fe of the Muvattupuzha river (28.59 ,38.25) is much higher than the dissolved Fe reported for some other Indian rivers like Cauvery (9.90ppb) and these does not exceed the maximum permissible limit of Fe (1000ppb) for drinking water quality standards [5]

Relative impact of Dissolved Manganese

$\max_I \min_j\{\lambda ij\}$= $\max_i\{24.82,24.45,20.35,18.59, 13.45, 13.18\}$
= 24.82ppb

$\min_I \max_j\{\lambda ij$ = $\min_i\{33.85,33.34,26.45,25.39, 18.38, 18.04\}$
= 18.04ppb

Thus the dissolved manganese in the Muvattupuzha river ranges from 18.04 to 24.82ppb and the dissolved Mn average is 22.78ppb lies in this interval.

CONCLUSSION

The modified fuzzy operator method reveals that the dissolved Fe and Mn in the river lies in the interval(28.59 , 38.25)ppb and (18.04 , 24.82)ppb respectively while the dissolved average of Fe and Mn calculated using mean and standard deviation methods are 36.25and 22.78ppb respectively and these belong to the intervals above. Thus the fuzzy approach is shown to provide an interval of possible solutions.

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