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Computaional Complexity Analysis on Water Quality Index

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***Abstract*— The computational algorithms are used to determine the features and applications from large data sets in real time environment. The computational applications are also used in environmental computing to evaluate the degree of air, water and sound pollutions and measures of prevention. The computational process of water quality index (WQI) is determined through analysis of water quality attributes. Though existing methods produced WQI with certain water quality attributes according to the nature and need of the applcations but it is not applicable to all other water quality attributes and the WQI computation procedures. The computing methodology of WQI is to be standardised for the assessment of the water quality which is applicable to all the domains in the same standard assessment process. Therefore, the complexity of computing the WQI value is analysed. In this paper, to evaluate the computational procedure, the WQI was computed by considering two different approaches classified into 9 water quality attributes by assigning standard weights and 6 attributes with different weights as a model. The same computation was carried out with possible combinational attributes analysis. The comparative study was made and the computational complexity is presented as part of this paper.**

***Index Terms*— Attribute weight assignment, Computational complexity, Quality rating scale, Water quality index.**

I. INTRODUCTION

The computational techniques are used to segregate and identify the properties of the combinational components and its properties. Many computing algorithms such as Artificial Intelligence, Neural Network [6], Clustering [1], Genetic Algorithm [15] and Classification are used to analyze the data. All the data processing techniques [14] are used to describe the properties of the attributes and to predict its behavior. The analysis process is applied to all the domains and its corresponding application processes are enhanced. The data analysis process is also applied in the field of environmental science as well as in geo-science. The environmental pollution analysis is one among the major challenges in eco-computation. In this approach, the main aspect of WQI is to study the water quality and to classify the same from the observed water quality attributes using selective measures and standards.

Water quality index is a single numeric expression reflecting the composite influence of a number of water quality attributes. In general, the WQI is computed by observing the physical, chemical and biological attributes of water quality. The attributes which play a major role are taken and WQI is computed applying one of the methods used. Since the computing methodology varies according to the number and type of attributes, the computed WQI values also vary. In this paper, the computational complexity is analyzed by changing the relative weight assigned to the attributes.

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II. SCOPE AND OBJECTIVES

The WQI is computed to assess the quality of water and its utilization. The WQI computation is executed using Horton index[10]. This paper is attempted to determine the impact on water quality attribute weight assignment for the specific number of water quality attributes. The weight assignments and its corresponding water quality rating are generated as pattern. In this work, the WQI computational standard, attribute selection and weight assignment procedures are evaluated.

As a case study, the computational attributes observed are taken from four different lentic systems for a period of two years on a monthly basis. Based on the influencing factors, different weights have been assigned to the selected attributes and WQI is computed. The same procedure is repeated with different weights and attributes to find the common weight prediction for WQI.

III. BACKGOUND

WQI approach has been applied in many countries such as India [16], United States [3], Indonesia [4], Canada [2] and Malaysia [11] to assess the overall quality of water in their water bodies. Kavitha et al., [9] attempted WQI computation considering the six water quality attributes of Dissolved oxygen (DO), Biological Oxygen Demand (BOD), Maximum Probable Number (MPN), Turbidity, Total Dissolved Oxygen (TDS) and pH applying the Bhargava method of WQI and classified the class of the water quality. According to Bhargava method, the simplified model for WQI for beneficial use is given by an equation which includes the relative weight and the sensitivity function. The Department of Environment (DOE) in Malaysia has developed a WQI calculation method, in which, the calculation procedure consists of three steps. The steps are to identify sub-index equation of based on the value of the parameter, to calculate sub-index of every parameter and to calculate the WQI.

Gatot EKO Susilo and Rina Febrina [4] also used the three step procedure to compute WQI having six attributes and also simplified the above procedure using graphical application. In this, WQI was computed without complex equations.

Munirah Abdul Zali et al. [11] followed the same computing methodology of DOE, Malaysia along with the Artificial Neural Network (ANN) technique to evaluate the significance of each parameter and to reduce the less significant parameter by performing WQI determination.

C R Ramakrishnaiah [13] et al. has assessed the WQI of Karnataka State, India also followed the three steps to compute WQI but considered 12 attributes. The water quality attributes have been assigned weight according to its relative importance in the overall quality of water for drinking purposes. The relative weight has been computed. Then the quality rating scale has been assigned and WQI was computed and classified the water according to the WQI index values [10]. He has used regression analysis model [13] to predict the dependent attribute total dissolved solids (TDS) from the independent attributes of Ca, Mg, SO_4, NO_3, Na and HCO_3 + CO.

Rajendra et al., [12] studied the water quality attributes for Tumkur Amanikere Lake Watershed, Tumkur, Karanataka, India and computed WQI considering 12 attributes (pH, total hardness, calcium, magnesium, bicarbonate, chloride, TDS, fluoride, manganese, nitrate, iron, and sulphate) along with Regression model for predicting the water quality and used the same three steps technique.

In this study, the WQI computation was made for the two sets of attributes. The WQI was computed from 9 attributes namely pH, turbidity, specific conductance, total alkalinity, total hardness, chloride, sulphate, Dissolved Oxygen (DO), faecal coliform bacteria in various combinations with certain weight assignments and 6 attributes namely pH, DO, Biological Oxygen Demand (BOD), Chemical Oxygen Demand (COD), nitrate and Total Suspended Solids (TSS) with different weight assignments. The above mentioned attributes are observed from the locations given below.

IV. DATA SOURCE

Water quality attributes have been taken from the doctoral thesis of Mohanraj Ebenezer, [10] the four lentic systems of Tirunelveli and Tuticorin districts. Water resources are classified as lentic and lotic. Lentic systems are those which contain stagnant water or closed system. Lotic systems are those systems which contain flowing waters. The data observed from the four lentic systems are below. Station I is the Udayarpatty Brathy pond which is situated in the heart of Tirunelveli Corporation and subjected to a high degree of modification due to local conditions. The area of the pond is about 1 1.5 acres. Station II is the Marthandeswar pond which is situated in a nearby village called Karungulam. It covers an area of 54 ha and 33 acres. Station III is a rocky pool, which the public is prohibited to use. It covers an area of 15 cents. Station IV is a large rocky pool and it covers an area of about 49 cents. The observed physical, chemical and biological attributes accounted for computing the WQI are listed in the table – 1.

In the observed data, in station I and II contained no water during the month of June therefore the data has been removed. The impacts of the various physical, chemical and biological attributes on water are described below.

pH is a measure of hydrogen ion activity which is used to express the intensity of acidic or alkaline condition of a solution. It is important in water analysis since it enters into the calculation of acidity, alkalinity and processes like coagulation, disinfection and corrosion control.

Turbidity is a principal physical characteristic of water and is an expression of the optical property that causes light to be scattered and absorbed by particles and molecules rather than transmitted in straight lines through a water sample. Turbidity is a measure of the degree to which the water loses its transparency due to the presence of suspended particulates.

Specific conductance is a measure of the ability of water to carry an electric current. *Generally*, rainwater has a very low conductivity. However, as runoff flows through a watershed, the slightly acidic nature of rainwater can release *ions* (negatively or positively charged particles) from soil and rock which dissolve in water and increase specific conductance.

Total alkalinity is the total concentration of bases in water expressed as parts per million (ppm) or milligrams per liter (mg/L) of calcium carbonate ($CaCO_3$). These bases are usually bicarbonates (HCO_3) and carbonates (CO_3), and they act as a buffer system that prevents drastic changes in pH.

Total hardness of water is water that contains high levels of dissolved calcium, magnesium, and other mineral salts such as iron. The greater the amount of dissolved minerals in the water, the harder it is.

Chloride is one of the major anions found in water and are generally combined with calcium, magnesium or sodium.

Sulphate is a naturally occurring substance that contains sulphur and oxygen. It is present in various mineral salts that are found in soil. Sulphate may be leached from the soil and is commonly found in most water supplies.

DO is the fundamental requirement for the maintenance of life of all living organisms in water. A water body is said to be polluted when DO level falls below a certain minimal concentration necessary for sustaining a normal biota for that water. Oxygen demanding substances can remove large amounts of DO from water, causes changing in their flora and fauna.

Total coliform bacteria are a collection of relatively harmless microorganisms that live in large numbers in the intestines of man and warm and cold blooded animals. They aid in the digestion of food. A specific subgroup of this collection is the *Faecal coliform bacteria*, the most common member being Escherichia coli. The presence of faecal coliform bacteria in aquatic environments indicates that the water has been contaminated with the faecal material of man or other animals.

Biological Oxygen Demand is the amount of dissolved oxygen needed by aerobic biological organisms in a body of water to break down organic material present in a given water sample at a certain temperature over a specific time period. The term also refers to a chemical procedure for determining this amount. This is not a precise quantitative test, although it is widely used as an indication of the organic quality of water.

Chemical Oxygen Demand test is quite useful in finding out the pollution strength of industrial waste and sewage. Chemical oxygen demand as is the amount of oxygen required for a sample to oxidize its organic and inorganic matter.

Total Suspended Solids determination is particularly useful in the analysis of sewage and other waste waters. It is used to evaluate the strength of domestic wastewaters and efficiency of treatment units. Suspended solids are objectionable in river for many reasons. Suspended Solids containing much organic matter may cause putrefaction and consequently the stream may be devoid of dissolved oxygen.

Nitrate is a naturally occurring form of nitrogen found in soil. Nitrogen is essential to all life. Most crop plants require large quantities to sustain high yields. The formation of nitrates is an integral part of the nitrogen cycle in our environment. In moderate amounts, nitrate is a harmless constituent of food and water. Plants use nitrates from the soil to satisfy nutrient requirements and may accumulate nitrate in their leaves and stems.

The observed values of water quality attributes differ from station to station. The attribute values are expected to lie within the range of standards.

Table – 1

Physical, chemical and biological attributes of four lentic systems / stations

S No	Attributes	Year I				Year II			
		S I	S II	S III	S IV	S I	S II	S III	S IV
1	pH	8.30	7.60	7.50	8.30	8.10	7.60	7.80	8.30
2	Turbidity	22.00	13.00	6.00	11.00	25.00	12.00	8.00	13.00
3	Specific Conductance	43.00	41.00	32.00	47.00	47.00	42.00	36.00	43.00
4	Total Alkalinity	67.00	39.00	76.00	61.00	56.00	41.00	18.00	53.00
5	Total hardness	61.00	47.00	21.00	51.00	53.00	41.00	17.00	61.00
6	Chloride	35.37	14.50	1.53	16.23	30.65	13.36	1.77	17.73
7	Sulphate	0.25	0.00	0.00	0.00	0.26	0.00	0.00	0.00
8	D O	5.80	6.80	7.80	5.40	6.00	6.80	7.90	4.30
9	Faecal Coliform	27845.00	15045.00	165.00	15700.00	30975.00	15950.00	62.00	14347.00
10	B OD	5.61	4.84	3.82	5.34	5.92	5.04	3.75	5.13
11	C O D	27.35	13.52	4.68	13.73	27.43	13.84	4.87	13.98
12	Nitrate	0.96	0.51	0.28	0.57	0.76	0.45	0.26	0.56
13	TSS	53.20	79.43	44.47	34.24	66.38	76.71	44.43	35.63

V. WQI COMPUTATIONAL PROCEDURE

The steps involved in computing the WQI is given below.
Step 1: The water quality attributes are selected and the observed values for each attribute are taken from the water source.
Step 2: For each attribute a weight value (Wi) is assigned.
Step 3: Based on the value and range of the attribute, quality rating scale (Qi) is computed for each attribute.
Step 4: The product of Wi and Qi is computed for each attribute.
Step 5: The sum of the product Wi and Qi is calculated which gives the water quality range and the value will be within 0 to 100.
Step 6: An index value 1 to 5 is assigned to the water source based on the obtained value.

VI. WQI COMPUTATIONAL COMPLEXITY

WQI is an arithmetical tool used to transform large quantities of water quality data into a single cumulatively derived number. The physical, chemical and biological attributes of water have been accounted for computing its quality. Though several methods are [2, 4, 6] adopted by various departments of environment, the general method applied is given below.

$$WQI = \sum_{i=1}^{n} Wi\ Qi$$

where 'n' refers to the number of attributes.
Qi value is the indication of water quality relative to 100 of one parameter.
Wi is the weighting factor sets the relative importance of the attributes to overall water quality.

Water quality index calculation is performed in two steps [10]. The selected 13 water quality attributes, namely pH, turbidity, specific conductance, total alkalinity, total hardness, chloride, sulphate, Dissolved Oxygen (DO), faecal coliform bacteria, BOD, COD, nitrate and TSS having different units of measurement are transformed into Qi value (ref. Table – 2).

For the 9 attributes, a set of weight values and for the 6 attributes, another set of weight values are assigned and the details are given in the Table – 3.

Table – 2
Quality Rating Scale for Water Quality Attributes (Qi)

S No	Attributes (units)	Degree of pollution and rating (Qi)			
		Permissible (100)	**Slight (80)**	**Moderate (50)**	**Severe (0)**
1	pH	7.0 – 8.5	8.6 – 8.8	8.9 – 9.2	> 9.2
			6.8 – 7.0	6.5 – 6.7	< 6.5
2	Turbidity (N.T.U)	< 5	5 – 10	11 – 25	> 25
3	Specific Conductance (μS/cm)	< 20	21 – 30	31 – 40	> 40
4	Total Alkalinity (mg/l)	> 50	51 – 85	86 – 120	> 120
5	Total Hardness (mg/l)	< 100	101 – 300	301 – 500	> 500
6	Chloride (mg/l)	< 200	201 – 400	401 – 600	> 600
7	Sulphate (mg/l)	< 200	201 – 300	301 – 400	> 400
8	DO (mg/l)	> 6	4.6 – 5.9	3.0 – 4.5	< 3.0
9	Faecal Coliform (No./100 ml)	ND	< 50	51 – 1000	> 1000
10	BOD	< 1	1.1 – 3	3.1 – 5	>5
11	Total Suspended Solids	< 30	30 – 65	66 – 100	>100
12	Nitrate	< 10	10 – 20	21 – 39	>40
13	COD	< 6	6 – 29	30 – 59	> 60

Table – 3
Weights of the physical, chemical and biological attributes of water

S No	Attributes	Wi [10] Method I	Wi [6] Method II
1	Ph	0.16	0.12
2	Turbidity (N.T.U)	0.16	-NA-
3	Specific Conductance	0.08	-NA-
4	Total Alkalinity	0.12	-NA-
5	Total Hardness	0.08	-NA-
6	Chloride	0.08	-NA-
7	Sulphate	0.04	-NA-
8	Dissolved Oxygen	0.16	0.22
9	Faecal Coliform	0.12	-NA-
10	BOD	-NA-	0.16
11	COD	-NA-	0.16
12	Nitrate	-NA-	0.15
13	TSS	-NA-	0.12
	Total	**1.00**	**1.00**

The WQI value is computed by multiplying the Wi and Qi values and by summing up all the WQI values of attributes as per the formula given above. The obtained WQI gives the water quality rating as per table – 4 given below.

The WQI was computed for four different lentic systems/stations using the data observed for two years on a monthly basis. The 9 water quality attributes with a relative weight and 6 attributes with different weights were considered and the WQI was computed and listed in table -5.

Table – 4

WQI Range	90 –100	70– 89	50 – 69	25–49	0 – 24
Water Quality Rating	Excellent	Good	Medium	Bad	Very Bad
Index	1	2	3	4	5

The WQI was computed for 9 attributes, 8 attributes leaving pH, 8 attributes leaving DO and 7 attributes leaving pH and DO and for 6 attributes, 5 attributes leaving pH, 5 attributes leaving DO, 4 attributes leaving pH and DO with the weight assignment as given in table – 5 and the computed WQI is listed in table - 6.

Based on the table-4, the WQI values obtained in the range of 0-100 has been classified using the water quality rating scale ranging from 1 - 5 and presented in table -7. The weight assigned for each attribute for the two different methods of computing WQI with the selection of attributes and its weight is listed in table–8.

Table - 5

WQI for Year – I Station – I with Methods I & II

S No	Attributes	S I	Method – I			Method – II		
			Qi	Wi	WiQi	Qi	Wi	WiQi
1	pH	8.30	100.00	0.16	16.00	100.00	0.12	12.00
2	Turbidity	22.00	50.00	0.16	8.00	NA	NA	NA
3	Specific Conductance	43.00	0.00	0.08	0.00	NA	NA	NA
4	Total Alkalinity	67.00	80.00	0.12	9.60	NA	NA	NA
5	Total hardness	61.00	100.00	0.08	8.00	NA	NA	NA
6	Chloride	35.37	100.00	0.08	8.00	NA	NA	NA
7	Sulphate	0.25	100.00	0.04	4.00	NA	NA	NA
8	Dissolved Oxygen	5.80	80.00	0.16	12.80	80.00	0.22	17.60
9	Faecal Coliform Bacteria	27845.00	0.00	0.12	0.00	NA	NA	NA
10	BOD	5.61	NA	NA	NA	0.00	0.19	0.00
11	COD	27.35	NA	NA	NA	50.00	0.16	8.00
12	Nitrate	0.96	NA	NA	NA	100.00	0.15	15.00
13	TSS	53.20	NA	NA	NA	80.00	0.16	12.80
	WQI			**1.00**	**66.40**		**1.00**	**65.40**

Table – 6

Computed Water Quality Rating										
		Year 1	**Year 2**	**Year 1**	**Year 2**	**Year 1**	**Year 2**	**Year 1**	**Year 2**	
Weight	**No. Att**	**S I**	**S I**	**S II**	**S II**	**S III**	**S III**	**S IV**	**S IV**	**Att Remarks**
W1	9 Att	66.40	69.60	72.00	72.00	84.40	86.80	66.40	61.60	
W1	8 Att	66.40	69.60	72.00	72.00	84.40	86.80	66.40	61.60	pH eliminated
W1	8 Att	63.81	63.81	66.67	66.67	81.43	84.29	63.81	63.81	DO eliminated
W1	7 Att	55.29	55.29	58.82	58.82	77.06	80.59	55.29	55.29	pH & DO eliminated
W2	6 Att	65.40	69.80	65.40	69.80	87.30	87.30	70.20	63.60	
W2	5 Att	60.68	65.68	60.68	65.68	85.57	85.57	66.14	58.64	pH eliminated
W2	5 Att	56.90	56.90	56.91	56.90	77.74	77.74	62.62	62.62	DO eliminated
W2	4 Att	54.24	54.24	54.24	54.24	80.76	80.76	61.52	61.52	pH & DO eliminated
Min		**54.24**	**54.24**	**54.24**	**54.24**	**77.06**	**77.74**	**55.29**	**55.29**	
Max		**66.40**	**69.80**	**72.00**	**72.00**	**87.30**	**87.30**	**70.20**	**63.81**	
Ave		**61.14**	**63.12**	**63.34**	**64.51**	**82.33**	**83.73**	**64.05**	**61.08**	

Table – 7

W Q I for different attributes										
		Year 1	Year 2	Year 1	Year 2	Year 1	Year 2	Year 1	Year 2	
Weight	No.	S I	S I	S II	S II	S III	S III	S IV	S IV	Remarks
W1	9 Att	3	2	2	2	2	2	3	3	
W1	8 Att	3	2	2	2	2	2	3	3	pH eliminated
W1	8 Att	3	3	3	3	2	2	3	3	DO eliminated
W1	7 Att	3	3	3	3	2	2	3	3	pH & DO eliminated
W2	6 Att	3	2	3	3	2	2	2	3	
W2	5 Att	3	3	3	3	2	2	3	3	pH eliminated
W2	5 Att	3	3	3	3	2	2	3	3	DO eliminated
W2	4 Att	3	3	3	3	2	2	3	3	pH & DO eliminated

Table - 8

Weight Assigned for Different Attributes

Parameters	9 Att	8Att	8 Att	7 Att	6 Att	5 Att	5 Att	4 Att
pH	0.16	NA	0.19	NA	0.12	NA	0.15	NA
Turbidity	0.16	0.19	0.19	0.24	NA	NA	NA	NA
Specific Conductance	0.08	0.10	0.10	0.12	NA	NA	NA	NA
Total Alkalinity	0.12	0.14	0.14	0.18	NA	NA	NA	NA
Total hardness	0.08	0.10	0.10	0.12	NA	NA	NA	NA
Chloride	0.08	0.10	0.10	0.12	NA	NA	NA	NA
Sulphate	0.04	0.05	0.05	0.06	NA	NA	NA	NA
DO	0.16	0.19	NA	NA	0.22	0.25	NA	NA
Faecal Coliform Bacteria	0.12	0.14	0.14	0.18	NA	NA	NA	NA
BOD	NA	NA	NA	NA	0.19	0.22	0.24	0.29
COD	NA	NA	NA	NA	0.16	0.18	0.21	0.24
Nitrate	NA	NA	NA	NA	0.15	0.17	0.19	0.23
TSS	NA	NA	NA	NA	0.16	0.18	0.21	0.24
Total	**1.00**	**1.00**	**1.00**	**1.00**	**1.00**	**1.00**	**1.00**	**1.00**

VII. DISCUSSION

1. Attribute Selection and Weight Assignment

In the process of WQI computation, observed weight Wi, assigned are given as a set for each attribute namely *pH, turbidity, specific conductance, total alkalinity, total hardness, chloride, sulphate, DO, faecal coliform bacteria* as {0.16, 0.16, 0.08, 0.12, 0.08, 0.08, 0.04, 0.16, 0.12} for the first method.

Similarly for the second method of WQI computation, the assigned weights for *pH, DO, BOD,* *COD, nitrate and TSS* are {0.12, 0.22, 0.19, 0.16, 0.15, 0.16}. WQI computation was carried out applying both the methods for all the attributes as well as elimination of pH and DO which are the common attributes. From the observation of the resulted table, the weights are asymmetric. The relational values between the weight and the obtained WQI are rational. The computing process is highly encapsulated with weight as well the quality rating scale Qi. In this process, the individual attributes are altered to evaluate specific changes on the impact of weight on WQI. Weight assignments and reassignments are given below.

2. Weight Reassignment for the attributes

For computing WQI, the selection of attributes was varied. Accordingly, the weights have also been reassigned. The reassigned weights are given in table – 8.

While calculating WQI with the elimination of pH, the reassigned weights for the first method for the attributes *turbidity, specific conductance, total alkalinity, total hardness, chloride, sulphate, DO, faecal coliform bacteria* are {0.19, 0.10, 0.14, 0.10, 0.10, 0.05, 0.19, 0.14} and the weights for *DO, BOD, COD, nitrate and TSS are* {0.25, 0.22, 0.18, 0.17, 0.18} in the second method. The computed weights for the selected parameters are rationally changed but the changed ratio is unpredictable. While eliminating DO from the first method the reassigned weights for the attributes *pH, turbidity, specific conductance, total alkalinity, total hardness, chloride, sulphate, faecal coliform bacteria* are {0.19, 0.19, 0.10, 0.14, 0.10, 0.10, 0.05, 0.14} and the reassigned weights for the second method, the attributes *pH, BOD, COD, nitrate and TSS* are {0.15, 0.24, 0.21, 0.19, 0.21}.

While computing WQI after the elimination of pH and DO from the first method the reassigned weights for the attributes are *turbidity, specific conductance, total alkalinity, total hardness, chloride, sulphate, faecal coliform bacteria* as {0.24, 0.12, 0.18, 0.12, 0.12, 0.06, 0.18} and the reassigned weights for the second method with the attributes *BOD, COD, nitrate and TSS* are {0.29, 0.24, 0.23, 0.24}

It is observed that the weights of the common attributes pH and DO have been increased to 0.03, specific conductance, total hardness, chloride by 0.02, sulphate by 0.01, faecal coliform by 0.02 and 0.04, BOD by 0.03, 0.05 and 0.1, COD by 0.02 and 0.03 and nitrate by 0.02 and 0.04 while computing the WQI with the alteration of number of attributes via eliminating pH, DO in a sequential manner for 9 attributes as well as 6 attributes. The represented weight shows that the method I and method II produced different weights.

3. Equal weightage for individual attributes

After eliminating the common attributes in both the sets of data, the WQI was compared. It is found that the WQI is same for both. Therefore it is concluded that in the assessment process, the weight values (Wi) assigned for *pH, turbidity, specific conductance, total alkalinity, total hardness, chloride, sulphate, faecal coliform bacteria* after eliminating pH and DO are {0.24, 0.12, 0.18, 0.12, 0.12, 0.06, 0.18} in first method is equally distributed to the attributes namely *pH, DO, BOD, COD, nitrate and TSS* as {0.29, 0.24, 0.23, 0.24} in second method.

4. Pattern Evaluation

The interesting set of values represented towards the objective is stated as a pattern. Based on the WQI, the corresponding index has been fetched for each of the four stations and each station for two consecutive years and represented as a pair to form the pattern for selective WQI computational model, according to table-7. The two different set of WQI are given below for comparison.

I Set WQI = {3, 2, 2, 2, 2, 2, 3, 3} where WQI is computed for 9 attributes

II Set WQI = {3, 2, 3, 3, 2, 2, 2, 3} where WQI is computed for 6 attributes

Case 1: Analysis of Station I

Station I values are taken as a subset. The subset, A_1 {3, 2} is taken from the set I. A_2 {3, 2} is the subset taken from the set II. In station I, the WQI for the corresponding two years is the same while computing WQI using 9 and 6 attributes. Similarly the computed and represented WQI are evaluated as per the table – 7. After the elimination of pH, {3, 2} of WQI is arrived in method I and {3, 3} is obtained from method II. Similarly while eliminating DO, WQI with first and second method are {3, 3} and {3, 3}. After the elimination of pH &DO, WQI produced as {3, 3} in both the methods. It shows that the elimination of pH alone produced dissimilar set on WQI, otherwise the WQI are identical.

Case 2: Analysis of Station II

Station II values are taken as a subset. In method 1 and 2 the subset values are {2, 2} and {3, 3} for 9 and 6 attributes as well as for the attributes after eliminating pH also. But, in method 1 and 2 the subset values are {3, 3}, after eliminating DO as well as both pH and DO. Therefore it shows that there is no change in method 2 but there is a change in method 1in the pattern of water quality which is extracted from WQI.

Case 3: Analysis of Station III

Station III values are taken as a subset. In the subset, C_1 {2, 2} = C_2 {2, 2}. In station III, WQI is same for the corresponding two years as well as in both the methods irrespective of the attribute selection. It shows that the combinations of both the method's pattern produced the same water quality level.

Case 4: Analysis of Station IV

Station IV values are taken as a subset. In the subset, D_1 {3, 3} $\neq$ D_2 {2, 3} for method 1 and 2 for all the selected attributes. The subset value is {3, 3} for all the attributes after eliminating pH, DO and pH and DO together. It shows that the values of the computation generate different values for the same attribute values. The migration of the pattern values are the impact of the minor changes in the computed water quality index range.

The above cases express that the WQI is same for station III only irrespective of the selection of attributes and the assignment of weights. Station III is a private rocky pool. Due to less pollution, there is no change in water quality and its index. Other stations are giving various values which are due to the complexity in computation.

VIII. CONCLUSION

This paper is intended to evaluate WQI computational complexity and its impact on applications. The same objectives are implemented with real time data set, the computed results are compared and discussed. The weight values are calculated and reassigned as per its existing ratio after the elimination of selected common attributes. Based on the reassigned weight, patterns have been generated. As per the evaluation of WQI values and its corresponding pattern, the reassigned weights are asymmetric. The actual attribute patterns differ while eliminating the pH values. The generated patterns overlap with the first and the second method. But, in elimination of DO as well as both pH and DO, the patterns are same. As per observation, first set having seven attributes and second set having four attributes have resulted same WQI values. However, the internal reactive levels of individual attributes are un-deterministic. Therefore, further research could be directed to determine the individual attribute reactive level using an appropriate model.

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