STUDY OF ARITHMETICAL VARIATIONS OF WATER QUALITY IN RIVER-GODAVARI BASED ON SEASONAL EFFECTS IN A.P.

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Abstract - Water is the prime requirement for the existence of life on earth. Most of the water for public water supplies and irrigation purposes is drawn from surface water sources like rivers and reservoirs as they facilitate the withdrawals of large amounts of fresh water. However, these surface water resources are getting polluted due to the joining of domestic sewage, industrial effluents and excess agricultural drainages. The study is conducted at two sampling locations on the River Godavari i.e., Polavaram and Dowleswaram which are located at a distance of 110.4 km and 152.4 km respectively from the entry point into the state. The data for the study is collected from Central Water Commission (CWC), India and Irrigation & CAD department, Hydrology project circle, Hyderabad, Govt. of Andhra Pradesh, for the years 2002 to 2017. The data comprised of several physico-chemical, biological and Irrigation parameters recorded daily. The two popular methods viz., National Sanitation Foundation Water Quality Index (NSFWQI) and Weighted Arithmetic Index Water Quality Index (WAIWQI) are used for the evaluation of the water quality indices representing the quality of water for both domestic and irrigation purposes at the two sampling stations. The water quality indices for the future period till 2020 are also evaluated. The overall observation from the study is that, the quality of water in the river Godavari is gradually decreasing while it flows from Polavaram to Dowleswaram and this may be because of joining of domestic sewage and industrial effluents from the towns Kovvur and Rajahmahendravaram located in the banks of the river. The seasonal variations of water quality of Polavaram and Dowleswaram has been focused in this study.

*Key Words***:** Water Quality Index, NSFWQI, WAIWQI, Seasonal variations of Water Quality.

1.INTRODUCTION

Water is the prime requirement for the existence of life and it has been man's endeavor from the time immemorial to utilize the available resources for his sustenance on earth. Water on earth is known by different terms, depending on where it is and how it is formed. Surface waters include the permanently or intermittently occurring inland waters on the earth surface either in liquid (rivers, streams, lakes,

reservoirs, wetlands) or solid (glaciers, snow covers) conditions. Most of the water for public water supplies and irrigation purposes is drawn from surface water sources like rivers and reservoirs as they facilitate the withdrawals of large amounts of fresh water. The modern agricultural activity with large scale use of chemical fertilizers and pesticides also contribute to the contamination of surface water resources due to the joining of excess agricultural drainages joining them. Thus, the quality of surface waters along with the quantities became a major concern globally. To Determine Water Quality Indices (WQI) w.r.t both domestic and irrigation purposes at two sampling stations viz., Polavaram and Dowleswaram on River Godavari. To Evaluate Seasonal variations of WQI at both sampling stations. To Conduct comparative study on water quality at both the sampling stations i.e., Polavaram and Dowleswaram.

2. METHODOLOGY

This study is bonded with the water quality of River Godavari. Godavari is the largest river of all peninsular rivers in India. It originates in Western Ghats at Trimbakeshwar, Maharashtra and flows eastward across Deccan plateau through the states of Maharashtra, Telangana and Andhra Pradesh. It flows through 1465 km eastwards and empties into the Bay of Bengal. It enters Andhra Pradesh at Gundala near Kunavaram, East Godavari District. The principal tributaries of River Godavari in Andhra Pradesh are Indrāvati and Sabari. These tributaries contribute 80% flow of the total river in Andhra Pradesh. The average yearly water flow in Godavari is nearly 110 billion cubic meters.

2.1 Data Collection

The data related to the Polavaram sampling location is collected from Central Water Commission (CWC), India for the years 2002-2017.The data related to the second sampling location i.e., Dowleswaram is collected from Irrigation & CAD department, Hydrology project circle, Hyderabad, Govt. of Andhra Pradesh, for the period from 2002 to 2017.The data comprises the values of the following physico-chemical, biological and irrigation parameters

recorded daily. The parameters considered in biological category are Dissolved Oxygen (DO), DO Saturated (DO_Sat%) and Biochemical Oxygen Demand (BOD). The parameters considered under irrigation category are pH, EC, TDS, Cl, Calcium Hardness, Total Hardness, Na%, Residual Sodium Carbonate (RSC) and Sodium Absorption Ratio (SAR).

2.2 Evaluation of Water Quality Index (WQI)

Based on the theory and literature review on WQI based studies, the two most popular methods viz., National Sanitation Foundation Water Quality Index (NSFWQI) and Weighted Arithmetic Index Water Quality Index (WAIWQI) are used in the present research work, to evaluate the water quality indices representing the quality of water for both domestic and irrigation purposes at the two sampling stations. The following text provides the procedural details for the evaluation of WQI in both the methods.

Table -1: Rating scale of NSFWQI

NSWWQI Range	Type of water
90-100	Excellent
70-90	Good
50-70	Medium
25-50	Fair
0-25	Poor

2.3 Multivariate Statistical analysis of data

Multivariate Statistical analysis of data is a body of methods that help to describe facts, detect patterns, develop explanations, and test hypotheses. It is a process of collation, presentation and interpretation of the information contained in the data to aid decision making. It is also a process used to transform, remodel and revise certain information (data) with a view to reach to certain conclusion for a given situation or problem. Data analysis can be done by different methods according to the needs and requirements of different domains. The Multivariate Statistical analysis of data involved in this study comprises of Cluster Analysis (CA), Factor Analysis (FA) and Principle Component Analysis (PCA).

2.4 WQI

A study with respect to the water quality into the future is conducted using the water quality indices obtained for the study period. Since, WQI is a numerical value representing the overall quality of water, a statistical method viz., the changing rate of increase/decrease is considered for the prediction of WQI values for the periods 2017-18, 2018-19 and 2019-20. It is assumed that the environmental conditions existing as on today at the sampling locations do not change considerably over the next three years.

3. RESULTS AND DISCUSSION

3.1 Missing Values

The univariate statistics related to the sampling station1 (Polavaram) and the sampling station2 (Dowleswaram), the following results of the missing values are shown in below tables.

Table -2: Sampling (S-1) of data collected from polavaram

Para meter	N	Me an	Std. Deviati on	Miss ing Cou nt	Miss ing Perce nt	No. of Extremes Lo w	No. of Extremes Hig h
DO	19 3	6.4	0.75	1	0.5	1	0
pH_GEN	19 4	8.15	0.32	0	0	3	0
EC_GEN	19 4	206.2 2	77.73	0	0	0	2
TDS	13 6	139.8 8	38.46	58	29.9	2	4
DO_SAT	19 3	81.87	8.08	1	0.5	6	0
NO_2+NO_3	19 4	0.48	0.58	0	0	0	7
BOD3-27	19 3	0.75	0.54	1	0.5	0	11
Har_Tot al	19 4	76.6	21.92	0	0	0	3
Ca	19 4	18.72	6.42	0	0	0	6
Mg	19 4	7.17	3.98	0	0	0	4
Na	19 4	13.11	5.34	0	0	0	2
Cl	19 4	12.93	6.21	0	0	0	11
SO_4	19 4	7.68	5.21	0	0	0	9
CO_3	19 4	2.66	3.92	0	0	0	7
HCO_3	19 4	92.29	24.7	0	0	1	3
RSC	19 4	0.13	0.16	0	0	0	9
Na_A	19 4	26.41	8.15	0	0	0	13
SAR	19 4	0.66	0.28	0	0	0	11
F	19 4	0.3	0.2	0	0	0	6
Alk_Phe n	18 2	2.24	3.28	12	6.2	0	6
Alk_TOT	19 4	80.11	21.87	0	0	0	1
NH_3-N	19 4	0.09	0.13	0	0	0	25

Table -3: Sampling (s-2)of data collected from Dowleswaram

Parameter	N	Mean	Std. Deviation	Missing Count	Missing Percent	No. of Extremes Low	No. of Extremes High
DO	174	7.48	0.98	5	2.8	8	6
pH_GEN	174	7.9	0.45	5	2.8	1	2
EC_GEN	174	197.05	57.25	5	2.8	1	5
TDS	176	103.6	35.05	3	1.7	1	4
DO_SAT	166	100.14	11.5	13	7.3	1	6
NO_2NO_3	160	0.82	0.92	19	10.6	0	8
BOD3-27	154	2.26	1.08	25	14	0	10
Har_Total	149	74.02	20.97	30	16.8	0	4
Ca	162	17.31	5.33	17	9.5	0	6
Mg	162	7.67	3.49	17	9.5	0	10
Na	161	11.32	4.65	18	10.1	1	5
Cl	175	20.67	10.78	4	2.2	0	15
SO_4	135	37.29	25.21	44	24.6	0	0
CO_3	151	2	5.45	28	15.6	0	0
HCO_3	159	79.81	23.15	20	11.2	1	5
RSC	151	1.09	2.12	28	15.6	0	25
Na_A	159	24.72	7.06	20	11.2	7	7
SAR	150	0.68	0.37	29	16.2	0	3
F	148	0.31	0.26	31	17.3	0	6
Alk_Phen	143	1.72	4.77	36	20.1	0	0
Alk_TOT	142	71.91	20.64	37	20.7	1	8

Table-4: Variation of percentage S-1

Parameter	Initial Mean	Mean after validation	% variation
DO	6.4	6.4	0.001
TDS	139.88	138.28	1.6
DO_SAT	81.87	81.88	0.01
BOD3-27	0.75	0.57	0.181
Alk_Phen	2.24	2.27	0.035

Table-5: Variation of percentage S-2

| Parameter	Initial Mean	Mean after validation	% variation
DO	7.479	7.48	0.001
pH_GEN	7.896	7.894	0.002
EC_GEN	197.052	196.774	0.278
TDS	103.602	103.581	0.022
DO_SAT	100.139	100.143	0.004
NO2+NO3	0.821	0.828	0.007
BOD3-27	2.255	2.302	0.047
Har_Total	74.02	74.359	0.339
Ca	17.309	16.975	0.334
Mg	7.675	7.76	0.085
Na	11.318	11.489	0.171
Cl	20.666	20.669	0.003
SO_4	37.286	37.699	0.413
CO_3	1.998	1.926	0.072
HCO_3	79.811	81.382	1.571
RSC	1.09	1.064	0.026
Na_A	24.717	24.558	0.159
SAR	0.683	0.69	0.007
F	0.308	0.314	0.005
Alk_Phen	1.717	1.626	0.091
Alk_TOT	71.908	72.664	0.755
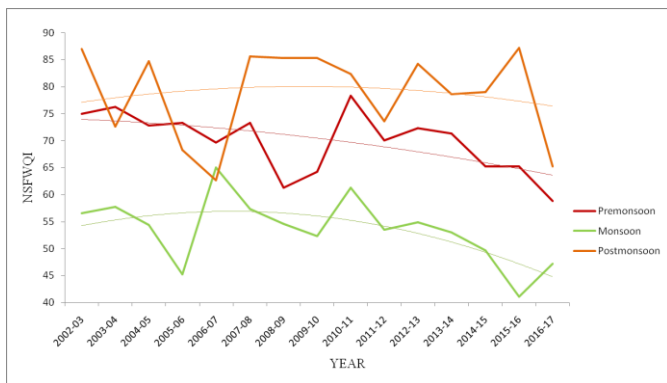
Fig -1: Variation of Seasonal at polavaram, Physico-chemical parameters (2002-2017)

Fig -2: Variation of Seasonal at polavaram, Biological parameters (2002-2017)

Fig -3: Variation of Seasonal at dowleswaram, Physico-chemical parameters (2002-2017)

At both the locations of the study, it is found that the quality of water is at lower rating during the monsoon seasons when compared with that of pre and post-monsoon seasons. This is because of the joining of flood water into the river and thereby increasing turbulence in the river water causing an increase in the turbidity and other suspended solids. The overall observation from the study is that, the quality of water in the river Godavari is

gradually decreasing while it flows from Polavaram to Dowleswaram and this is because of joining of domestic sewage and industrial effluents from the towns Kovvur and Rajahmahendravaram located on the downstream side of Polavaram and upstream side of Dowleswaram.

Fig -4: Variation of Seasonal at dowleswaram, Biological parameters (2002-2017)

4. CONCLUSION

1.   From the WQI based studies related to the physico-chemical parameters, vide above tables the quality of water in River Godavari is found to be good at Polavaram and poor at Dowleswaram for the domestic usage.

2.   Based on the WQI values related to biological parameters vide tables, it is found that the river water quality is medium at Polavaram and poor at Dowleswaram.

3.   It is further found that the quality of water in River Godavari is having a lower rating during the monsoon season w.r.t the domestic usage when compared with that of the pre and post-monsoon seasons at both the locations of the study.

4.   This may be because of the occurrence of flash floods influencing the turbulence of the river water causing an increase in turbidity, dissolved solids and other impurities and thereby affecting the quality of water.

5.   Further, it is found that, the water quality of river Godavari for domestic usage is deteriorating from the years 2014-15 from medium to poor.

6.   On the whole, the river water quality for the domestic usage is found to decrease gradually while it flows from Polavaram to Dowleswaram and this may be because of joining of domestic sewage and industrial effluents from the towns Kovvur and

Rajahmahendravaram located on the banks of the river.

7.   From the study related to the WQI predictions into the future years vide tables , it is found that the same trend of deterioration of water quality may continue into the future years unless suitable measures are taken up to stop the contamination of river water body from the domestic sewage and industrial effluents joining from the towns Kovvur and Rajahmahendravaram.

8.   The Factor Analysis and the Principal Component Analysis conducted as a part of multivariate statistical analysis of physico-chemical parameters at the sampling location Polavaram vide § 5.2.5 and § 5.4.5, identified Alk_Tot and Har_Total as the influencing parameters.

9.   The similar statistical analysis conducted at the sampling location Dowleswaram identified two more influencing parameters i.e., TDS and EC_GEN along with Alk_Tot and Har_Total, which shows that more amount of impurities are joining the river course and increasing the dissolved solids component and thereby decreasing the quality of water while the river flows from Polavaram to Dowleswaram.

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